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ABSTRACT

The third volume of a three-volume report on a three-year study of the use of computers in secondary school classrooms, this document explores research themes and summarizes findings and recommendations. The overall purpose of the project, which was conducted by the education faculty at the University of Western Ontario, was to examine the effects of computer use on classroom teaching and learning and on the structure and presentation of curricular materials. This report covers: (1) assumptions and practices teachers use to develop their pedagogical styles; (2) a summary of the history of educational computing in Ontario and the incorporation of computer use into provincial course guidelines; (3) the use of computers as personal tools by students and teachers; (4) the physical design of classroom environments and the search for an optimal form of computer installation; (5) the ways in which young women experience computer use differently from young men; (6) the time teachers need to become familiar with computer use and the impact of familiarity on adoption of computers in high schools; (7) issues of in-service and pre-service training; and (8) policy recommendations for consideration by school boards throughout the province, including suggestions for improved physical designs, more and better training, positive steps to combat sexism, and a renewed emphasis on computing as a means of transforming classroom teaching. (Contains 83 references.) (KRN)

RUCCUS
Research Unit on Classroom Learning and Computer Use in Schools

Closing the Circle: Conclusions and Recommendations

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ABSTRACT

This summative report is organized into three volumes: Volume 1 reviews the context of the research project: its organization, the basis of the research strategy that was used, and the character of the schools, teachers and students involved. Volume 2 contains the Principal Investigators' reports from each of the sub-projects. Volume 3 explores a number of research themes, and summarizes the findings and recommendations which have emerged.

This volume takes its central focus from our belief in the importance of context to the understanding of educational practice. It begins with an examination of the basic cultures and subcultures which make up the micro-society of a school. This analysis reveals a fundamental set of assumptions and practices, upon which individual teachers develop their pedagogical styles within the constraints of their subject areas. A summary of the history of educational computing in Ontario is presented in order to portray the processes by which the provincial government has attempted to establish a standardized central core of computing hardware and software. It is noted, however, that the present standards evolved fro those that were originally proposed nearly a decade ago.

Building upon this foundation, we next examine the incorporation of computer use into provincial course guidelines. In general, we find that computers, and their potential for transformative teaching, are not yet presented as prominent features of course guidelines in the areas under study, nor in the "curriculum ideas" series available from the Ministry. Our critique of the concept of computer literacy reveals that this concept remains rather vague, and that it does not by itself provide an adequate grounding for the kinds of educational experiences espoused by the Ministry.

The next section investigates the use of computers as personal tools by both students and teachers. Whereas most students are keen on the idea of computerized writing, a significant minority are found to express doubts, or to have had negative introductory experiences which have discouraged them from using computers extensively for their own work. Computers were used as motivators by many of the participating teachers, but it remains an open question as to whether this is having a significant positive effect on classroom environments.

We also review the physical design of those environments, and the search for an optimal form of computer installation. Most teachers in the project say that they would prefer to have both a computer laboratory and classroom clusters, but tend to be influenced by the kind of installation they have used during the project (as they have little basis for comparison). A quantitative analysis of classroom interaction patterns reveals that the strong influence of subject subcultures is evident, and that there is also an effect produced by computer use. However, no interaction between these influences is apparent.

An extensive section on gender issues in classroom computing reveals a number of ways in which young women experience computer use differently from their male counterparts. Although high school girls tend to have some skills and abilities which give them an advantage in computer use over boys, there is a lingering perception of computing as male territory. This perception expresses itself most clearly in situations where unregulated use takes place. In these situations, males tend to dominate the use of the computers.

One of the most important influences on the adoption of computers in high schools is the time available for teachers to become familiar with them. Participating teachers repeatedly identified preparation time as the most significant constraint on their use of the computers. These issues are seen to overlap with issues in in-service and pre-service training in the final analysis section.

The volume, and the report, closes with a series of policy recommendations for consideration by the Ministry and by school boards throughout the province. These recommendations arise out of our analyses of the context of classroom computing, and include suggestions for improved physical designs and support, more and better training, positive steps to combat sexism, and a renewed emphasis on computing as a means to the end of transforming classroom teaching.

- August 30, 1991

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By Ivor Goodson, Marshall Mangan, and Valerie Rhea

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3.1.1 SUBJECT SUBCULTURES AND THE ECOLOGY OF HIGH SCHOOLS

Teaching and learning, like all communicative action, generates more messages than can be received. They are, in Jules Henry's terms, "polyphasic"; more goes on than we realize. No one ever teaches, or learns nothing; no one teaches or learns only what is intended. The total curriculum is always complex, multiple and, taken as a whole, often incoherent. It follows that such things as the identities, motives, inclinations and dispositions of teachers and learners are never incidental to teaching and learning: they are always integral, and sometimes dominant.

Fine-grained analysis of teaching as interaction can therefore only produce partial accounts. The whole is inevitably greater than the sum of the parts. If we are to track the messages transmitted and received, modified and created, we need to look as closely at biography and context as at the immediate transmission of signs. Educational "strategies" cannot be solely accounted for in terms of classroom action; the analysis must include aspects of motivation, identity, setting, situation and context. To be complete it must consider what is perceived as well as what is received, and it must consider pattern as well as detail. From the point of view of research, strategies for teaching and learning are best considered as keys to the understanding of experience rather than as theories that explain. Accounts of the strategies of individuals provide windows on the culture in which interaction, biography, social context and history intermingle, clash or fuse. For these reasons we have sought in this research project to collect data in a variety of ways and in a variety of arenas. We have combined classroom observation with workshop discussions, life history interviews, documentary evidence, and other data sources.

Our analysis of teaching strategies in secondary schools provides a view of an intersection of three aspects: the cultures of teaching, the cultures of subjects and personal histories and styles. These three aspects merge and clash with the introduction of a new culture, the culture of computing.

3.1.1.1 <u>Cultures of Teaching</u>

Larry Cuban's *How Teachers Taught* (1984) has eloquently shown how historically stable the classroom cultures of teaching have been since the turn of the century. In the same year, John Goodlad, in a study of five classrooms in U.S. high schools found that the lecture format predominated and generated a set of core activities: explaining/lecturing/reading aloud by the teacher; discussing, preparing for and working on assignments; and taking tests (Goodlad, 1984). A year later Tye's study confirmed the pattern. In twelve American junior high schools, she found that students spent large amounts of time listening to the teacher. In addition to this, the most common activity, they also spent time writing answers to questions, and often took tests or quizzes. (Tye, 1985).

This basic culture of teaching constitutes a substratum, a bedrock of teaching fundamentals which is so much taken-for-granted that it is usually invisible, and unavailable to teachers and students for critical reflection. It can be observed, however, by outsiders who temporarily suspend their familiarity with the setting. For our purposes, it is worthwhile to make this substratum explicit once again, even if it seems to be stating the obvious. Doing so can provide us with a fresh view of classrooms as sites for the production and reproduction of a distinct subculture. This

new perspective can, in turn, lead us to see how the introduction of computers can clash with this culture, and the problems that are thereby raised.

In our project, participating teachers displayed different mixtures of the elements which make up this fundamental culture, but virtually all elements were evident at some time in all teachers' practice. These elements include:

- Standing at the front of the class and delivering lectures on the subject's principles and certain points of fact.
- Delivering the "notes": short written precis of important content. These are often written on the board to be copied verbatim. At other times, teachers give instructions such as "write this down" or "don't bother to put this in your notes."
- Individual coaching. At some point, every teacher has been observed to circulate among students and offer suggestions on the performance of some assigned task.
- Administering written and/or practical assignments and examinations, and marking them according to an established grading system.

Upon this bedrock, we may conceive of other "layers" of classroom culture being built, including subject-area subcultures, and personal histories and styles.

3.1.1.2 Cultures of Subjects

Given that our focus in this research is on secondary schooling, a major variable in the take-up of computers is the subject being taught. To some extent each subject in the secondary school is a separate microcosm, a microworld with varying values and traditions. In a real sense we found evidence that teachers experience their subjects as separate "subcultures". These have been discussed at some length in earlier interim reports (Goodson, Mangan & Rhea, 1989b, pp. 29-35; Mangan and Goodson, 1990, pp. 91-93). They reflect the perceived need for some subjects to be taught in different ways from others, in order to allow for the distinctive character of the subject to be transmitted more effectively. In this project a rough descriptive categorization of these subcultures looks like this:

A. Social studies: history, geography, sociology:
   1. Content-oriented. Generally larger class sizes. Teacher talk dominates.
   2. "Socratic" method is frequently cited by teachers. This is taken to mean:
      a. Classroom lectures, often overlapping with reading assignments.
      b. Frequent questioning of students during in-class reviews.
      c. Repetition of material in several media, including examination questions.
   3. A generally formal classroom format. Students usually sit in rows, face front, and work independently. Teachers tend to maintain an atmosphere of quiet, and group attention to a single task.

B. Art: commercial and visual arts
   1. Less emphasis on content and lecture style, except in art history sections. Note that this exception constitutes a blurring of boundaries; "Modern Civilization" courses cover art history, in a style virtually identical to that in art courses.
   2. A greater emphasis on individuality and creativity. Students are often urged to originate their own compositions. However, teachers will offer hints to students who are in difficulty. They are also capable of being didactic regarding issues of technique, colour blending, etc.

3. Higher frequency of individual coaching and demonstration.
4. As a corollary of the above, a generally less formal classroom atmosphere: more noise and movement, more casual conversation between teachers and students, greater tolerance for background noise (e.g., music) and, in some cases, (with mature students) less strict monitoring of attendance.

C. Technological studies/family studies: drafting, electronics, foods, clothing. These subjects offer a kind of middle ground between the arts and social studies: they are oriented towards the practical, but contain a fair amount of theoretical material.
1. Lectures and dictation of notes are fairly common, but usually only occupy the first quarter of a class period. The remainder of the period is usually taken up with a practical exercise.
2. In performing the practical assignment, there is a reduced emphasis on individuality or creativity. Instead, the emphasis is on the correct execution of prescribed instructions: measuring, drawing, sewing; cooking according to recipes.
3. Individual coaching is commonplace, but the relationship between teacher and student is still somewhat more formal, and classroom discipline is slightly stricter, than in most art classes.

All of these features can be seen to be linked to different production tasks within the subject subcultures. In social studies, students primarily produce written output or graphical displays; in art, drawings, paintings, and sculptures; in technological and family studies, a practical artifact. The nature of these tasks in shaping classroom cultures is also overlaid by other variables: the age level and difficulty grouping of the class, for instance. The atmosphere in one teacher's grade 9 class, for example, was radically different from that observed in her class for mature students.

3.1.1.3 Teaching Styles and Teachers' Lives

In most cases, teachers perceive their pedagogical style as a limited arena of personal choice, in which they have the freedom and power to make minor variations in curriculum and pedagogy. These variations are constrained by both the fundamental culture of teaching and the subject subculture.

In this project certain interesting juxtapositions of personal style and cultural factors have emerged—for instance, the use of educational technology and media. Walter Harvey, for instance, likes 16-mm films, while the other geographers rely more on models, maps, and blackboards. The history teachers make extensive use of videos. Diane Mirabella regularly uses overheads and filmstrips, but few other technological media.

Teachers vary the particular format of classroom discussions and Socratic questioning: relying on volunteers, or picking out individuals; having student-led discussions or teacher-directed quizzes. There were also observed differences in the degree of "assigned co-operation": some teachers encourage more group work and student interaction than others. One, for instance, has an explicit philosophy about this and says she is careful to match up different sets of students throughout a semester, in order to encourage a range of social interaction. Similarly, some teachers are more inclined to rely on peer coaching and tutoring than others. Some have formal peer-evaluation procedures; others have none.

More than one teacher in this project has said that teaching style is an expression of a teacher's personality. If this is true, the implication is that a change in style would require nothing less than a change in personality. The difficulty of enforcing such a change should be obvious, and is sometimes acknowledged by the teachers themselves:

> I think that if I categorize my teaching style, it's been, like, fairly obviously teacher-directed.... But I think if I want to use the computers more, with three in the room, I've got to be more flexible in letting kids work at a different pace, work on different things at different times.... So it means sitting down and doing some fairly, uh, drastic revisions of ways I've done things in the past, to tailor it more to individuals or to small groups.

In the life-history interviews, teachers have often expressed two basic themes regarding their teaching philosophies. First, that they care deeply about their students, and are interested in opening up some form of novel learning experiences for them. Second, that their teaching styles derive directly from their concept of education and its intersection with their personal lifestyles. Diane Mirabella, for instance, says she "likes everything up front", and tries to teach the same way. Harry Thorne describes himself as "content oriented", and structures his classes accordingly.

Some of the more senior teachers, particularly from social studies, have indicated that they rely more on experience than on preparation to get them through their classes. Elliot says:

> ... I find it fairly easy to come in some days unprepared, then fall back on my experience, or fall back on the fact that I know a certain page in the textbook has some information that's necessary, and to have the kids read it.

This may be taken as an indication of such teachers' complete immersion in and identification with their subject subculture. For them, teaching their subject comes naturally, and hardly requires conscious preparation.

What are the implications of this close identification of teachers' lives with their professional practice for the introduction of computers? How does it influence their reaction to the challenges of classroom computing—challenges which not only confront their technical abilities and impose new demands on their time and energy, but which may demand significant changes in their teaching strategies and styles?

3.1.1.4 Teaching Subjects and the Introduction of Computers

As we have seen, the cultures of teaching are closely linked to the cultures of subjects in the so-called "specialization years". These subject subcultures precede the introduction of the computer. They represent the terrain into which a new (alien) force, the computer, is being introduced. In this sense we have chosen to talk of "*antecedent subject subcultures*" as a major variable in understanding the introduction of computers to classrooms (see Goodson, Mangan & Rhea, 1989a; 1989b).

Teachers talked about their subject subculture particularly with regard to patterns of classroom practice and classroom control, as can be seen in these excerpts from interviews with the art teachers.

Wendy: People don't face the front in art rooms ... they get up and they move around all the time. And they're facing each other and uh ... in a circle around the room.

This pattern presents its own problems of classroom management, because the classroom environment is:

> terribly unstable I'd say ... most of my job is people control. Uh ... it'd be nice if it was teaching art, just teaching art, but it isn't.

The insertion of computers into such an environment has the potential to either exacerbate or relieve problems of control:

Interviewer:	How does the computer fit into that? What you're tending to say is that in fact you think if you had only three [workstations], it would actually, if anything, increase your control problems aren't you? (laughs)
Wendy:	It takes three children out of the classroom. So if you have a class of twenty-eight and then all of a sudden you have three less. ... Every little bit helps. (laughs)
Interviewer:	That's right.
Wendy:	Three at the back doing something they're very interested in. ... Or the people from the day before will be sent back, all three of them will be sent back to teach the next three. So that could be six. All back, very busy, very happy, very absorbed in something productive.
Interviewer:	So that's a real plus.
Wendy:	That's always a big plus. I guess, I guess nothing's a problem if it's, if it works. If it makes them happy and learn something and uh ... I don't think that could be a problem, you know.

Likewise, in family studies, the antecedent subject subculture favours a classroom where different students carry out different tasks. In short an individualized classroom environment already exists, and the introduction of computers is fairly unproblematic in such an established classroom terrain:

Interviewer:	So, do you normally do whole classroom activities at once, or will this just be normal for you, to have certain students doing different things?
Betty:	Well, in family studies we often have different groups doing different things.
Interviewer:	So that won't be a major adaptation for you, you'll be able to just...
Betty:	No. Especially the sewing project—I mean their rate of doing things is so varied in that some finish before the others have cut it out! So you have all these people at different stages, so I think it will be handy for that! You can enrich the program for the faster ones ... in a way that, you know, I think they would find interesting, rather than just another sewing assignment.

In other subjects the pattern of "whole class" teaching poses great problems for those wishing to introduce computers. We have found this particularly the case in some history and geography classrooms. Harry Thorne, when asked how computers fit into his social studies classroom, replied:

Harry:	It's an extra right now, yes.
Interviewer:	It's not in the fabric in your class planning really?
Harry:	And I'm finding more and more it's difficult to actually think of ways to include it for an entire class. And I think one of the limitations is that

there are only three of them in the room. I can't count on having the three here or the three in the geography room at any given time. And it's also a reflection that I haven't really sat down and tried to organize a class computer-related program.

Although the antecedent subject subculture provides an important variable in the take-up of computers in the classroom, there are commonalities as well as differences in the ways teachers introduce computers into their lessons. On the whole, we found *very few* examples of teachers fundamentally re-working their lesson plans and pedagogy. This was expressed in a continuing theme in the interviews that the computer was "just another tool"—"just another way of learning". What this phrase probably summarises is the belief that computers will *not* substantially change the way teachers conduct their lessons and their classroom learning. Barb Cunningham stated that:

> I would like 7 to 10 computers in here, because I know a lot of times we don't always have to be on the computer and, in the business, *the computer is just another tool. It's just another medium.* And if you go to a studio ... now what they do—you know—they go to the drafting table, work something up, work up the graphics, go to the computer, do what has to be done by the computer. ... They bring it back if they have to paste something up or—you know—if they have to put in an illustration or whatever, they have to scan something, they scan it ... so um, *basically it's just another tool.* So we need it for this, but we're going to go back and do this. A lot of times, you know, you can do roughs on the computer, but in a lot of cases the real rough, rough work has to be done on paper anyway, you know brainstorming and stuff like that. So, uh, if you see a studio, usually they have computers—they're slipping back and forth between the two, because they don't always have the computer all the time. [Emphasis added].

The notion of the computer as a tool is also reflected in students' comments on the use of computers in their classrooms:

Student #1: Well, sometimes, like, they're sort of like an outlet—a recreation, sometimes. 'Cause in the paint, like, we'll be doin' work, like, drawing pictures or whatever, but that gets boring after a while, you know, sometimes you have the mood to do it, and sometimes you don't. When you don't, you just sit there, but the computers gives you another option to try something different for a while.

Interviewer: Yeah. So, do you look on it then as just another medium—like, I mean, it could be painting, it could be doing silkscreening, and you could be working on the computer—or is the computer like a whole different kind of experience?

Student #1: It'd be just like learning more about it in—in a different way. Like, learning—like you could be learning history about computers, you can learn geography on the computer, and math on the computer, art, drafting, anything.

Interviewer: Right.

Student #1: *It's just another way of learning.*

A further proof that the computer is being used for routine, *existing* practices is the theme of "replacement". Small bits of existing lesson plans are replaced by computerized bits but the basic objectives and structure remain much the same. Carl Higgins described his approach this way:

I like the idea of work centres, you see. So if I can have three students working on a work centre where they're concentrating on one part of the curriculum ... it's a different method to the method that I would normally employ. No, I don't see it as being extra work, other than the fact that I have to learn it myself, because, I mean, let me give you an example. Let's suppose that we have this *CAD Tutor* in place. ... It would be a very good thing when I've mastered it and I can sit down with three students and say "I want you to do this exercise and this is how you basically go through doing it". Give them the demonstration, and then have them do it. And then rotate another three kids through. Uh ... now I will eliminate something from the curriculum in order to insert that little piece, okay? So that gives me the time. So I'll kill something off that I don't think is as necessary as the *CAD Tutor*. And the same will apply to the electronics program. Uh ... something that I think is more usefully done on the computer, I will eliminate the old method to make the space.

The computer then is most enthusiastically taken up where it fits with existing practice and causes no substantial changes in content or pedagogy. In art, for instance:

Interviewer: So, do you feel that you've made any major or drastic changes to your lesson plans, or your teaching style, to accommodate these computers?

Wendy: I don't think so. I think it fits in quite nicely in the classroom.

Interviewer: Uh-huh.

Wendy: I don't think I've had to do too many things differently because of it.

Interviewer: From the observations that [we] did before the computers came in, it looked to us as though you basically were sort of coaching kids. You let them work largely on their own, you walk around and give them individual help, right?

Wendy: Uh-huh. That's how an art room runs, most of the time.

Interviewer: So you feel they fit in all right in that way, as well?

Wendy: Oh, they especially fit in because of that set-up in the classroom. It's not mostly a teacher talking for half an hour, and students then doing their work. It's everybody working, and me helping them solve problems. And the computer is, is -- just presents a new series of problems to be solved by the students, too, so. ...

This teacher, then, feels that the computers, as delivered, do not disrupt the culture of her classroom. By contrast, teachers in other subjects may feel they have to modify their use of computers to ensure that they do *not* disrupt the established subculture. Ed Thompson summarizes this pattern of the co-option of computers into the existing framework:

Interviewer: If we get geography software, is that going to solve the problem of your teaching style and your classroom management, or are there going to be new problems down the road even if there is geography software?

Ed: We're always going to have to adapt whatever they give us to our own teaching style, or our own content orientation, or whatever the case is. Because I dare say there will never be a program that fits me exactly, or what I want to accomplish. It may come close, but I don't think there will ever be one that I can say "Hey, that's perfect for me, and let's go with it." I may be wrong there, but what I've seen, I don't think so. ...

In many ways, Chuck Grambling provides an interesting case study within our study. He is virtually unique among our teachers in being a junior teacher, but one brought up entirely within the established pedagogical tradition. He has incorporated computer use rapidly into his practice, but with few alterations to his style. His use of screen dumps to make up worksheets is perhaps best characterized as a co-optation of the technology: he incorporates it fully, without allowing it to alter his basic pedagogy.

3.1.1.5 <u>Co-option or Adoption?</u>

What we see at stake here is indeed the traditional patterns of subject knowledge and subject learning. Subjects are well-established bodies of knowledge and social practices. They carry with them assumptions about "worthwhile knowledge", "good students", "effective teaching", and "excellent results". Potentially the computer can enhance these established social procedures or disrupt them. Teachers can co-opt the technology, but in some instances they can also "surrender" to it. In extreme cases this can lead to the actual replacement of subject learning by technical learning—a replacement in short of the academic by the vocational. Not all teachers resist this. Ed Thompson, an enthusiastic innovator with computers, described the transition:

> Yes it has changed the way I teach geography. I've downplayed content and moved to teaching skills—in a way I see myself teaching computing first and geography second ... and that's fair enough I suppose because knowing computing will get them jobs ... whereas geography ... well what can I say?

Of course this view expresses an extreme pendulum swing, directly away from subject teaching to technical training. In the process, Ed is actually led to denigrate the relevance of his own subject specialty. But the quote expresses the "either/or" view that is prevalent among many. *Either* I can co-opt the computer to broadly fit what I am already doing (and think I do well), *or* my existing subject and practice is *overthrown* and I become a technical trainer. Very few teachers articulated the view common in the rhetoric of guidelines and computer publicity: that computers will revolutionize classrooms and massively enhance the efficiency and scope of subject teaching and learning.

The co-option of computers by subject teachers is an example of a very common response to innovations, and to the lack of sensitivity toward teachers which often accompanies them. As one teacher pointed out: "if you look at the history of computer use in secondary schools, it's like everything else, it's been brought on us from above." Initiatives "from above" are not always seen by teachers as well-informed or indeed well-intentioned. They are sometimes viewed as essentially political responses to powerful pressure groups in society. Hence by this view, it could be argued that it has been judged politically expedient to introduce computers to accommodate business and economic interests. Such an interpretation would certainly apply to the quote above, in which a teacher sees his customary practice being displaced by vocational demands.

Teachers often respond pragmatically to innovations "from above". In general they co-opt the initiatives and continue broadly as before. In a previous study, a teacher summarized the general response to new guidelines in this way: the teacher searches out how to go on doing what has always been done in the new context (see Goodson, 1980). The question in one teacher's words was:

> How can I do what I've always been doing in a new context? ... though it would have been a new thing in terms of the syllabus (new guideline) ... So it was a question of reshuffling his pack of cards, really. (ibid., p. 257).

With the introduction of computers we find much evidence of reshuffling the pack of cards, but little evidence of anybody trying a new game. It is possible for the culture of computing to completely colonize some areas of the curriculum. In most areas, however, the antecedent subject subculture in effect colonizes the computer, and uses it to teach the existing subject in the existing way. In this established practice the computer becomes "just another tool".

3.1.1.6 Implications for Change in Project Classrooms

There are two basic facets of planned change to be introduced by classroom computing. The first is the adoption and incorporation of computing machinery into everyday classroom practice. If the above analysis is correct, this would be contingent upon several factors, including: a) whether classroom computing is seen to conflict with the priorities of the fundamental cultures of teaching and of subjects, or as making demands that would inhibit the faithful adherence to these cultures; b) whether there is software available which fits in with the subject subculture, either in the form of a specific curricular package, or a multi-purpose tool; and finally, c) whether teachers can see payoffs in terms of easing their own administrative burdens, or of being able to produce evidence of professional competence and performance, through the use of computers.

The second challenge which confronts the introduction of computers is the modification of teaching styles to encourage the more individualized learning which computers both demand and facilitate. The achievement of this change is more tricky. It depends upon all of the above factors, plus the element of the teacher's personality. If, in fact, teachers feel that they have a very limited range of flexibility in individualizing their teaching style, and if they feel that what is individual about their style is closely connected to their own personalities and their philosophy of life, then the adoption of a new style of computer-integrated teaching may present a challenge to some very deep-rooted and personal feelings.

Teachers may also incorporate computers into their practice in a very limited way, as just another tool, consistent with their personal styles. In other cases, the introduction of computers has achieved a complete conversion, and the teachers' only criticism is that it moves too slowly. It is worth noting, however, that where we have been able to observe such conversions, teachers explain it via an explicitly vocational rationale.

3.1.1.7 Conclusions

In this section we have provided evidence that a change such as the introduction of computers into classrooms involved much more than the addition of a new technical armoury to existing classroom resources. The introduction of computers in fact sets off a *culture clash*: a clash between cultures of teaching, subjects, personal styles and cultures of computing.

In this culture clash the teachers, who are at the centres of events, often see an "either/or" choice: either I can co-opt the computer to broadly fit what I am already doing (and think I do well), or I and my existing subject and practice are overthrown and I become a technical trainer. These views may represent only the early stages of the culture clash; perceptions may soften as cultural interplay and negotiation proceeds. We should not be in any doubt, however, that the teachers at the heart of this ongoing negotiation consider that there are major issues at stake.

3.1.2 THE DEVELOPMENT OF COMPUTERS IN EDUCATION IN ONTARIO

The development of the use of computers in education has a relatively short history in Ontario. Although there does not seem to be any official written history, Ontario Ministry of Education (MOE) policy memos, press releases and various newsletters have proven to be quite informative in tracking the stages of its decade-long development. This development, which is summarized in Figure 3.1, will be discussed in terms of its phases: a few computer's, initial plans for a common system, major steps for commonality, software development, single-system plan breakdown, revisions, reactions, increased diversity, and the development of the curriculum document.

3.1.2.1 Early Years: Few Computers, Great Variety

While the business and public sectors were becoming increasingly involved in computing, prior to 1980 there was not much organized activity in the area of computers in education. There were, however, three areas of interest, namely: Data Processing and Computer Science (secondary level), Computer-Assisted Instruction (elementary and secondary levels) and Distance Education (correspondence courses). These groups combined did not amount to a great deal of computer use, for in June of 1980 there were only 649 computers in Ontario schools, mainly developed by Commodore, Radio Shack and Apple.

Figure 3.1: Timeline of Related Activities

1979 - little action in educational computing
1980 - 649 computers in Ontario schools
1981 - establishment of Advisory committee on Computers in Education
- 3239 computers in Ontario schools
- Bette Stephenson announces need for computer literacy for all students; plans for educational microcomputer

1982 - Memo 47: stating that computers were to be used creatively and for information retrieval; grants for purchase of computers
- call for software development to run on existing hardware
- 6000 computers in Ontario schools

1983 - March 24: a day of many announcements regarding computers in education; Memos 68-73
- specification of criteria for hardware in schools; as no existing units meet it, these must be created
- provincial assistance with purchase of computers (75% paid); software to be developed by Ministry, field-tested extensively
- November: CEMCorp has ICON prototypes developed, meeting Ministry's specifications

1984 - software developed, field-tested; 6 calls from Ministry for software development proposals
1985 - REE grants available to boards for hardware purchases; ICON only approved machine at this time
- CEMCorp joins with Burroughs
- 30 products from initial software call have been converted various systems to ICON
- SDAC formed, first CALM Development Newsletter
- 10 000 ICONS in Ontario schools

1986 - IBM EDNET approved for GEMS funding
- OAEM replaced by GEMS; "pedagogy must lead technology"
- 47 programs converted to ICON
- plans for Software Portability Environment announced (EASI)
- Unisys new name of combined Burroughs/Sperry company

1987 - Memo 91 - integration of computers into elementary and secondary curricula; "all students shall have the opportunity"
- 108 programs available in OESS, all for the ICON
- 17 000 GEMS workstations in Ontario schools; 80 000 total
- Stage II specifications released

1988 - funding of six Lighthouse Projects, plus other research projects
- $3 million funding directly to boards to purchase software
- revision to specifications for hardware; Canadian content rules revised; $180 million spent 1980-1988; total of 105 000 computers
- Provincial Auditor criticizes Ontario's initiative

1989 - revisions in funding; other equipment and training can be included for funding
- 3 more GEMS: Commodore Com-Link, Apple Macintosh, Tandy ED-LAN GEMS approved
- September: total of 121 397 computers in Ontario, 51% of which were GEMS
- request for proposals for EASI
- Ministry plans to end software development by 1993, rely on EASI interface to allow software compatibility

1990 - begin development of curriculum document on implementation of computer technologies across curriculum
- March: contract for EASI layer awarded; is to allow new programs to run on any GEMS
- two more GEMS: Atari gemNet and Olivetti Acorn Archimedes A3000
- $254.5 million spent to date on hardware
- percentage of grants which may be used for 1B machines, peripheral equipment, and inservice activities increased to 35%
- a total of 12 software calls to date, and 225 contracts awarded; 167 Ambience software programs have been released, 5 non-Ambience programs, 6 utilities and 2 compilers; Ministry plans to provide 74 French language programs in next 3 years; 75 English packages under development, to be released in next 2 years.
- additional $10.9 million in last 3 years for purchase of software by boards in an effort to increase flexibility; Software Acquisition Program Committee established to determine school board priorities for software purchases from vendors
- first prototype of EASI delivered

1991 - MOE presently funding 15 implementation projects across province
- Educational Software Catalogue released with 149 English, 53 French OESS programs; later releases with 4 programs to run on MS-DOS and Macintosh systems, 11 more for ICON
- Memo 113: REE grants for 1991 for GEMS, peripherals, and professional development totals $40.9 million; $4.9 million for software; funding procedures and reports to be written by school boards; goal of one computer for every 10 students
- Draft Policy Document of Ministry's *Computers Across the Curriculum: Junior Kindergarten to Grade 12/OAC*; outlines rationale, goals, aims, and responsibilities of teachers, principals, boards, and Ministry, replacing Memo 91.

3.1.2.2 First Steps: Initial Plan for Common System

In October of 1981, the first major announcement regarding computers in education was made by the Minister of Education (Stephenson, 1981). Reacting to the need for a highly skilled labour force, computer literacy and equal education opportunities for all children, the Ministry had consulted with the Canadian Advanced Technology Association (CATA), representing the Canadian micro-electronics industry. CATA identified the functional requirements of an educational computer as seen by the teachers and senior educators of Ontario. Other provinces reviewed this and supported common specifications in hardware, equipment and cataloguing across the country. In a combined effort, the Minister of Industry and Tourism also announced plans to form a new company to manufacture an all-Canadian educational microcomputer fulfilling these requirements. Funding was promised to Boards to purchase computers meeting these requirements. The Board of Industrial Leadership and Development (BILD) pledged $2 million over the next two years for the development of educational software.

In February, 1982, Policy/Program Memo 47 (MOE, 1982a) was released, expanding on the earlier statement. It stated what was to become the Ministry's long-standing position on computer use in schools:

> There will be two fundamentally different ways to use computers in the process of teaching and learning. The more significant way will be the creative use of the computer by individuals: writing, composing, designing, analyzing, and other extensions of original thought. All students must be given opportunities to use computers in this way. The second...is to gain access to learning materials and information resources. (p.2)

A month after this, G. R. Podrebarac (MOE, 1982b) issued a request for proposals to developers for "Exemplary Computer-Based Learning Materials". Although this software was to be of high quality and relative to current curriculum guidelines for Ontario, there were no stipulations on which system it should run, thereby offering developers a choice of any existing hardware.

3.1.2.3 Major Steps: Common System of Hardware and Software

March 24, 1983 was a day filled with great promises and publicity regarding computers in education, with the release of ten different announcements or memos (MOE, 1983a-j). The document entitled *Functional Requirements for Microcomputers of Educational Use in Ontario Schools—Stage 1* (MOE, 1983b) was released, filled with stipulations about features, uses, Canadian content, networking and safety considerations for microcomputer systems. The basic concept was to provide a system with a fileserver, 12-16 workstations, a standard keyboard, a mouse or trackball, 640x240 mono monitor/320x240 colour monitor, minimum 64 K RAM for users, and the support of BASIC, Pascal and Logo. Provincial assistance (75% funding) was promised to Boards purchasing these new computers which would be built by CEMCorp, a new Canadian company. Increasing support for software development was promised: $1.3 million in 1983, $5.46 in 1984 to $10 million by 1986. This was in addition to the response to the first software call a year earlier, where 57 of 510 proposals received were selected for funding.

These microcomputers produced by CEMCorp came to be known as ICONs by the time the prototypes were delivered to the Ministry in November of 1983 (MOE, 1983k). The Ministry's pride in its accomplishment can be seen in a paper presented by the Deputy Minister of Education

(Fisher, 1983). He referred to the ICON as "the world's finest educational computer" (p. 9) and defended the Ministry's actions by saying,

> For the first time, a microcomputer has been thought out from the ground up to meet educational needs. Had we not backed a Canadian company willing to take a risk with private capital, we would have remained the victims of the industry. (p. 10)

3.1.2.4 Full-scale Software Development

The next year passed quietly in comparison, with on-going development and field-testing of a variety of software designed to run on the ICON. Various private developers, under contract to the Ministry, were involved in the creation of educational software programs aimed at all levels, primary through senior. The development of these programs included a time-consuming, rigorous examination by Ministry personnel, as well as field-testing in Ontario schools. In addition to the new developments, a "conversion team" was also selected to convert selected software programs developed from the 1982 call to run on the ICON.

In March, D. A. Penny (1985) of the Ministry of Education delivered a paper entitled, "A Provincial Policy Response to the High-Tech Impact on Education". Following the Ministry's general line, he stated that computers would lead to increased individualized instruction, greater mastery of content, accelerated cognitive development, and an expanded range of concepts. The role of the teacher would be altered as well, as the computer could perform many of the routine duties of the teacher, leaving more time to emphasize functions beyond training.

Memo 82, released in May 1985 (MOE, 1985a), summarized many of the Ministry's initiatives in computers in education. Recognized Extraordinary Expenditure (REE) grants totalling $20 million were offered for the purchase of Ontario Approved Educational Microcomputers (OAEM, later to be called Grant Eligible Microcomputer Systems, or GEMS). Thirty products from the original software call in 1982 were now able to run on the ICONs, with more promised, as six new software calls were issued in 1984 with additional calls in 1985. A user-friendly environment developed by the Ministry, under which all Ontario Educational Software Service (OESS) programs would operate, called Ambience, was also introduced at this time. Professional development was indicated as well, with a list of options for those teachers seeking computer training.

As the software development increased, the Ministry opened the Software Development Assistance Centre (SDAC) in 1985 to be a resource centre for developers of computer-assisted learning materials. Located in OISE, it was to also produce a monthly computer-assisted learning materials updates, which came to be known as *CALM Development Newsletters,* offering a variety of information to software developers.

Software development efforts and hardware acquisition by school boards continued steadily. By the end of 1985, just two years after the first prototypes appeared, there were 10 000 ICONs in Ontario schools, at a total cost of $40 million, $30 million of it paid by the Ministry. A selection of 59 pieces of software developed for the ICON was available free to all schools.

3.1.2.5 Single-System Plan Breakdown

At the beginning of 1986, however, D.A. Penny (MOE, 1986a) announced that the IBM EDNET system had also been approved for grant eligibility as it also met the specified functional requirements. Anticipating the problem of software incompatibility, he stated that a common

environment for educational software would be available soon, ensuring that all software acquired for Ontario schools would be compatible with any qualified system. At this time, the term OAEM was also replaced with Grant Eligible Microcomputer Systems (GEMS).

The Ministry's accomplishments were again highlighted by Steve Solway (1986) in his glowing description of the Ambience of the system. He also summarized its approach to computers in the classroom as recognizing that "pedagogy must lead technology by ensuring that the learning objectives provide motivation for our technological objectives" (p. 4).

In June of 1986, the Ministry issued another call for software for the Junior Division and Business Studies and unveiled their proposal for the Software Portability Environment (SPE), designed to ensure compatibility of software and hardware that was to be developed with funds provided by the Ministry. The rest of 1986 passed with the release of a research study funded by the Ministry as well as the announcement that Unisys was the new name of the combined Burroughs/Sperry company which had previously joined with CEMCorp.

The Ministry next released Memo 91 (MOE, 1987a), stating the new policy regarding integration of computers into elementary and secondary curriculum. Recognizing that computers were increasingly influencing teaching methods, they firmly set down their expectations. "All students...shall have the opportunity, to the full extent of their abilities, to become knowledgeable and creative in their use of computers as personal tools" (p.1). According to this memo, students must see computers as a self-help tool in everyday life. Educators developing curriculum at all levels must include, where appropriate, suggestions on the use of computers, "including statements on the most appropriate applications for students and for specific disciplines" (MOE, 1987a, Appendix, p.2).

The Ministry's position was once again stated by W. G. Mitchell (Mitchell, 1987). They saw the microcomputer as a vehicle for learning about things rather than learning about the microcomputer itself. He also stated that the purpose of designing hardware all along was to enable the development of software particularly suited to education. The software and hardware picture was still growing, with 108 programs available in OESS, 47 more under development and 17 000 GEMS workstations in Ontario schools. Still considering further development, later that same year, the *CALM Development Newsletter* (McLean, 1987) reported that the Ministry was exploring the CD-ROM as another option and "hopes to begin distribution of OESS software on CD-ROM, possibly as early as September 1988" (p. 2).

The Ministry enhanced its software and hardware development with research plans and projects in 1988. Reports were made on six Lighthouse Implementation Projects, and plans were made for research at Regional Test Sites across the province for GEMS as well. Responding to the requests of Boards, $3 million more funding was also promised for the purchase of ready-made software, to suit the boards' individual educational and hardware needs, not necessarily GEMS equipment (1988a).

3.1.2.6 Revisions

Five years after the release of the original document, a revision of the functional requirements for hardware was released in July, 1988 by the Ministry (MOE, 1988b). Specifications were altered, allowing more manufacturers the possibility of meeting GEMS approval. The Canadian content requirements were also revised to allow calculations to be based on either product content or corporate content. Once again, the software compatibility issue was addressed, with a statement

that all licensed software would only be available under a common software portability environment (SPE) based on the Educational Application Software Interface (EASI) to be defined in a document in the Fall of 1988.

3.1.2.7 <u>Reactions</u>

A big blow to the Ontario Ministry of Education came in November of 1988, with the release of a review of Computers in Education in the Provincial Auditor's Report (1988). There had been various critics of the computer effort all along, but this was the most specific and the most public criticism. While acknowledging that several good quality software products were developed, the auditor felt that there were extensive delays in their development and some ineffective field-testing. He also noted that not all of the objectives were met in the development of the unique hardware that was high in cost and slow in implementation. He felt that more emphasis on implementation, teacher training and effectiveness research was needed.

Chris Ward (1988), Minister of Education at that time, responded by saying that he agreed with the Auditor's criticism of the development of a single ideal computer saying that his ministry began revamping its computer policy more than a year ago, offering more flexibility, rewriting specifications, announcing a software portability project, and offering boards the opportunity to use a portion of their funds (25%) to purchase less expensive, task-specific computers and 5% to provide teacher training. Prior to this, the onus was on the teachers to provide for their own professional development. This announcement recognized the significance of teacher training in computers and the boards' responsibilities in this area.

3.1.2.8 <u>Increased Diversity in Software and Hardware</u>

As expected, during the year 1989, many computer companies were able to fulfil the revised functional requirements for computers. By the end of the year, there were a total of six grant eligible systems, totalling 30 000 machines in the schools, from five vendors: Commodore ComLink, Apple Macintosh, IBM EDNET, IBM AN/ICLAS, Tandy ED-LAN and Unisys ICON. (This is in addition to the 70 000 non-GEMS systems in the province!) By this time, there were nearly 200 OESS software programs released or in development, virtually all of which would run solely on the ICON. To this list were added the Atari gemNet and Olivetti Acorn Archimedes systems in 1990. These developments made the need for the EASI software portability tools, designed to overcome the incompatibility problem, even more crucial. While the initial call for proposals for its development had gone out in July 1988, with a second in November 1989, the contract for its development was not awarded until March of 1990, with the first prototype delivered later in 1990.

In December 1989, Bernard Shapiro announced that by 1993 the Ministry would completely remove itself from software development and that the functions of the CCRT will be integrated into the rest of the Ministry, while planning to continue to provide funds for software purchases, relying on the EASI layer to provide compatibility among its grant eligible machines.

3.1.2.9 <u>The Curriculum Document: A Guide to Implementation</u>

The final steps to date in Ontario's educational computing history regard the development of a document providing direction to educators on how to integrate computer technology into all areas of the curriculum. In 1990, the Ministry began the development of this curriculum document

to guide the further implementation of computer technologies in education. The draft of this document was introduced in Memo 113 (MOE, 1991a), which also outlined new policies regarding funding for hardware, professional development, software, and new procedures to be followed by boards in planning and budgeting for computers. The draft curriculum document, entitled *Computers Across the Curriculum, Junior Kindergarten to Grade 12/OAC: Draft Policy Document* was released a month later, in June 1991 (MOE, 1991b). It outlined the aims, goals and responsibilities of teachers, principals, boards and the Ministry, replacing Memo 91. Among other items, it stated that students should have opportunities to use computers for a minimum of 2.5 hours per week to acquire and maintain computer skills. This cross-curricular use of computers requires one computer for every ten students, a goal towards which all boards must work.

3.1.2.10 <u>Conclusion</u>

The Ontario Ministry of Education has spent a great deal of money (over $250 million in 10 years) and effort in its microcomputer initiative, which has greatly increased the level of computer awareness across the province. A great deal of high quality software, directly applicable to the Ontario curriculum, has been developed and is available to schools free of charge. Its admirable policy that computers are to be used firstly as creative tools and secondly for information retrieval for students of all ages was consistent throughout the decade.

The entire plan to have a common system of hardware and software specifically suited to the needs of education is ambitious. In reality, however, it did not work out quite as planned. With the luxury of hindsight, we can see that hardware developers **did** actually change to meet the requirements of the Ministry, and it may not have been necessary at all to ever have created a new company or microcomputer. With the variety of GEMS and non-GEMS systems which are presently available in the schools of Ontario, there seems to be little hope of any commonality among systems. While this has led to a problem of software availability on certain systems, it is hoped that the eminent release of the EASI layer may solve some of the compatibility problems of future programs.

Again, Ontario has taken some very brave first steps in the area of microcomputers in education in the past ten years. We may now boast of having a variety of high-quality systems in our schools which can only serve to enhance the experience of education in Ontario. This, combined with a great deal of software pertinent to Ontario's curriculum and the associated training for teachers will lead us through the 1990's ahead of many school systems, and has made us, using the words of Bill Lipischak, "the envy of most educational jurisdictions at least in the Western hemisphere" (CALM Development, May/June 1990, p. 3).

3.1.3 THE INCORPORATION OF COMPUTERS INTO SUBJECT GUIDELINES

3.1.3.1 <u>General</u>

While computers have been used in schools for the past ten years, there has been relatively little guidance in the form of curriculum documents for teachers as to how they should undertake such implementation. The recent release of the *Computers Across the Curriculum, Junior Kindergarten to Grade 12/OAC: Draft Policy Document* (MOE, 1991b) has offered more guidance in this area, as it outlines not only the Ministry's rationale and goals, but what it considers to be the responsibilities of the teacher. While one must recognize that this is only a draft document at

this time, it offers a view of the Ministry's concern with this integration. The listed responsibilities for teachers include the following:

- co-operating with other staff members in planning programs
- ensuring that programs recognize learners' needs and abilities
- establishing ways in which computers can be used to accomplish curricular aims and objectives and identifying and organizing resources to support the planned activities
- providing learners with opportunities to use computer technology for problem solving, communicating, collaborating, experimenting, and creating through a variety of activities
- providing equitable access to computer learning activities for all learners to meet their individual needs
- continuing to develop competencies in the use of computer technology for integration into their classroom programs
- modelling the effective use of computer technology to their classes
- evaluating learner progress in learning activities, considering all factors including the learner's use of computer technology in particular learning activities
- evaluating the components of their classroom programs that involve the use of computers by learners in terms of their meeting learner needs
- reflecting on their planning and making revisions as necessary (p. 30)

3.1.3.2 Art

In addition to these general responsibilities for teachers, Ministry curriculum guidelines also offer teachers guidance for their specific subject area. While these suggestions are also often quite vague and very brief, they offer support and flexibility to teachers using computers in these subject areas. For example, the current visual art curriculum guideline (MOE, 1986a) includes a page discussing computer applications and electronic imaging (p. 106). In addition to a discussion of the rationale behind such use are five types of activities designed to foster an appreciation of electronic media, briefly:

- the study of the colour theory of light;
- studio projects that incorporate the dimension of time (e.g. sequential photographs, storyboards, video art, performance art);
- the study of the physical principles of electronic imaging, that is, how the picture finds its way onto the screen;
- the study of video as a medium of artistic expression;
- the study of existing video and electronics art.

This document also lists the following computer applications or approaches which can be used in various visual arts courses (p. 106): graphic tablets; computer-assisted design (CAD); tutorials; drill and practice programs as applied to studies in perspective; simulations for planning patterns, programming related to mathematical designs (e.g. *Logo*); "painting" packages; and sprites and icons.

3.1.3.3 <u>Technological Studies and Family Studies</u>

As might be expected, the technological studies guidelines also refer to computer use. The document referring to the electrical grouping (MOE, 1985b) contains a brief section referring to the general use of computers:

> As computers and appropriate software become available to the schools, opportunities for students to successfully accomplish independent study activities will increase. Confidence gained through these opportunities is particularly important to young people who can expect to face a working life characterized by changing technology and the constant need to update their skill and knowledge.
>
> The effective use of computer programs as learning tools in the classroom can require adjustments in teaching strategies. Although students continue to need hands-on experiences with the materials, tools, and equipment associated with courses in this grouping, computer programs applied at appropriate times can help the teacher to teach, reinforce, review, and test the associated learning. (p.3)

The technological studies guidelines have also changed to include courses specifically dealing with this new form of technology in computers. In the electrical grouping (MOE, 1985b), Computer Technology is offered as a senior division course, based on the curriculum guideline for computer studies (MOE, 1983l). In addition, an Ontario Academic Course is also offered, focusing on the technology for interfacing computer-controlled devices with the computer (MOE, 1987b).

The Ministry document referring to the textiles grouping (MOE, 1986b) in this same series contains virtually the same passage as that cited in the electronics grouping (MOE, 1985b), with the additional statement that:

> Students should also have opportunities to become aware of the various tasks that computer technology performs in the production and service industries associated with subjects in this grouping. Visits to these industries and related institutional training centres can show students how computer technology is used to facilitate access to information and to control functions related to sewing, cutting, designing, and pattern development. (p. 3)

A similar statement is included in the food services grouping guideline (MOE, 1986c), with the inclusion of the use of computers to process information as well as control some food production operations (p. 3).

The technological studies document referring to the graphics grouping (MOE, 1986d), which includes, among other subjects, both drafting and vocational art, also contains the statement from the electronics grouping above, with the additional expectations that:

> Students should also have opportunities to become aware of the various tasks that computer technology performs in the graphics industry. Visits to engineering and architectural design establishments can introduce students to the uses of CAD (computer-aided design) systems on both specialized and comprehensive work projects. Visits to commercial printing establishments can provide insights into the applicability of computer technology to a wide range of operations and production tasks in the graphic communications industry. (p. 3)

3.1.3.4 <u>Social Studies Areas</u>

Given the fast-moving nature of the introduction of computers into schools, it is not surprising to find that the extent of coverage of computer-related activities is related to the recency of issue for a given subject area's guidelines. The history and contemporary studies guidelines, for instance, were issued in 1986. They contain a small section on "The New Technologies" (MOE, 1986e, p.32) but this section still refers to microcomputer use largely in terms of its potentiality, rather than its actuality in the classroom. Even so, a prominent feature of this guideline, and one which has generally been consistent in the discussion of computers in Ontario curriculum documents, is the way in which computers are related to the larger goals and objectives defined in these texts. The section mentioned above, for instance, opens with:

> The Ministry of Education is supporting the development of computer software programs that can be readily incorporated into history and contemporary studies courses. These programs provide opportunities to reinforce and extend many cognitivie skills and achieve the knowledge objectives of this guideline.

It is also commendable that this guideline explicitly supports a critical attitude toward the use of computer software:

> Teachers will still need to encourage students to test the information in software programs for reliability, bias, accuracy, and so on. In this regard, students should be encouraged to identify limitations in the new technology.

The guidelines for senior/intermediate geography were updated in 1988, making them some of the most recent available to this project. As such, they reflect the more current policies of the Ministry. Although computer use is not a prominent feature of the geography "Policy and Program Expectations" document, we do find there such statements as:

> - Computers allow students to work in groups to accomplish a variety of tasks that promote co-operation and provide meaningful questions for discussion.
> - Many computer simulations involve students in role playing and decision making that require advanced orders of thinking. Often the issues and questions that are raised require the conscious examination of values and attitudes, the pursuit of further information, and the development of skills.
> - Computers can help the teacher to move from the roles of authority figure and information provider to the roles of facilitator and consultant. (MOE, 1988c, p. 23)

In these statements, we begin to see more of the emphasis on computers as a means of altering pedagogical styles and classroom relationships. Consistent with other Ministry statements, they advocate a greater emphasis on collaborative learning and crtical attitudes toward values and attitudes.

Unfortunately, there do not seem to be many explicit examples of the incorporation of computers into social studies courses available from the Ministry. The series of "Curriculum Ideas for Teachers" in these areas date back to the late 1970s and early '80s, and they contain few if any references to the use of software.

Our examination of subject guidlines reveals that, although computers are not a prominent part of any of the current documents, there are mentions of the incorporation of computers into each of the subject areas under study. In the more reflective moments during which these guidelines are compiled, the relationship of computer technology to the goals defined by the central statements of the Ministry are usually made clear. As the following section on "The

Ideology of Computer Literacy" will attempt to show, however, this relationship is sometimes lost or muddied in the mix of pressures related to the implementation of computers in schools.

3.1.4 THE IDEOLOGY OF COMPUTER LITERACY

There are many "costs", in terms of training, support, and preparation, implicated in the introduction of school computer use. Although most students and teachers remain enthusiastic despite these costs, it behooves us from time to time to re-examine the basic rationales used to justify the introduction of computers into classrooms, and the associated costs.

Perhaps the most common such rationale is the concept of "computer literacy". It is a concept, however, which is poorly defined and delineated (see Noble, 1984; Ragsdale, 1988). In its most common form, it is essentially a vocational argument: computers will be very much in evidence in future workplaces, therefore students must have some knowledge of how computers function in order to be comfortable and competent in such a workplace.

Another form of the computer literacy argument does not rely entirely on the concept of vocational training, however. It rests more on a kind of technological fatalism, which suggests that computers are going to be "everywhere" in the future—from banks to grocery stores to TV sets to cars—and that, whether students will need computer skills in their work or not, they need to have some general idea of how to operate a computer console just to deal with these exigencies of daily life. If computers will be everywhere, then why not in the schools?

Finally, there is the more purely pedagogical argument, that learning about computers is a worthwhile experience in and of itself, that it encourages the learning of formal logic and mathematics (on which all computer functioning is based), and that computers can be useful productivity tools for other academic work.

Together, these arguments constitute what might be termed "the ideology of computer literacy". "Ideology" may seem to be too strong a term, suggesting as it does that the concept of computer literacy constitutes a belief system which grounds a range of social and political actions, and which works to the advantage of certain social groups while disadvantaging others. Computer literacy may not be as neutral as some of its proponents assert, however. In fact, some critics (e.g. Bowers, 1989), have attacked the claim of value neutrality as itself ideological. In any event, it may be illuminating to at least examine the nature of "computer literacy" critically, as we would a more easily-recognized ideological system. In the process, we may discover that this widely-accepted concept actually conflicts with other established educational values and goals.

3.1.4.1 Re-examining the Reasons for Educational Computing

As many critics have pointed out, the concept of future job markets requiring computer skills rests upon a superficial analysis of vocational trends (see, for instance, Apple, 1986, 1987; Menzies, 1989). The number of future jobs which will actually require the ability to either program a computer, or deal with sophisticated software in some creative way, will be a distinct minority of the positions created by the Information Age. Rather, the biggest growth areas will be in service and clerical jobs, precisely because traditional semi-skilled jobs are being displaced by automation. Professional-level information management jobs will increase, but not as fast as these more mundane occupations. Even so, there may be a justification for an emphasis on computer literacy within our particular project, given the aspirations of the participating students.

In a similar way, the fact that computers are everywhere, from grocery store check-outs to fitness parlours, hardly implies a requirement for computer skills. Many of these systems have been designed to be "user-friendly," but that very "friendliness" is based on making the operation of the machines as simplistic as possible, usually requiring only a minimum of reading abilities and motor skills. Understanding the principles of operation behind such machines is neither required, nor particularly beneficial. In fact, troubleshooting these machines, which used to be a part of the operator's job, is now no longer possible for any but the most highly-trained and well-equipped technicians. General computer skills will not, for instance, make modern automotive engine-management systems understandable to the average motorist. Many components are, in fact, sealed to prevent tampering by amateurs. Today's cars are not only totally inaccessible to the ordinary user, they cannot even be repaired by mechanics who lack the necessary high-tech diagnostic machines.

Thus, the vocational justification and the ubiquity argument can be questioned. It may, however, still be the case that computer use encourages the development of general organizational and problem-solving skills. This is a frequently-made claim, although the empirical evidence for it is sketchy (see Beynon, 1989). Even on purely pedagogical grounds, there is room to question some of the elements of the ideology of computer literacy. All of the arguments cited rest on some further assumptions: that all computers share some common elements of operation, that learning about one computer will help a student learn about others, and that computerized learning is cumulative. Experience with one kind of computing is assumed to contribute to the development of attitudes and skills which will facilitate further computer literacy. Can these assumptions always be taken for granted?

Space does not permit us, in this Summative Report, to delve as deeply into these issues as they deserve. We can, however, review some of the evidence accumulated so far in our participating classrooms, to see what the state of computer literacy as an educational enterprise is at present in our project's schools.

3.1.4.2 The Ideology Embodied: Reactions from Teachers and Students

The notion of the inevitable ubiquity of computers is certainly well-established in the schools we studied, among both teachers and students. In talking with them about their notions of computer literacy, however, we discovered quite a range of reactions to this concept. Although the majority of interviewees believe that computers are the "wave of the future", and that they need to ride that wave to insure their own success, not everyone is enthusiastic about the prospect. These interviews also indicate that the assumptions about the cumulative nature of computer knowledge, and its transferability both to other computers and other logical tasks, are by no means irrefutably established. Enthusiasm for classroom computing is in evidence in these remarks by Elliot Nance:

> I think they're important in the classroom, I think they're going to be important in society, if they're not already. I'd like my own kids to be much more comfortable with computers, just as a way of being able to cope if they have to. So I think by the same token I'd like my students to be comfortable, to recognize that the computer's a pretty powerful machine, can do them a lot of good, especially if they have more mastery or control over it. Now they may already be at that point. In a lot of cases, they're ahead of me, I think. So I still think there's some value in working at implementing computers

fully into the system. I guess if I didn't I would've backed out of the project by this point. ... We'll probably have to have a mandatory course in computer literacy that every student will take, and maybe, if necessary, over two years.

Clearly, this teacher accepts the scenario of a future world permeated by computers. His reaction is motivated by a genuine concern for the welfare of his students. What he wants for them is what he wants for his own children: an increase in their competence and power in dealing with the world of information processing. In his opinion, this is important enough that it warrants forcing computer literacy upon students if necessary, through mandatory courses of up to two years' duration. Most other teachers share this commitment. Carl Higgins says:

I was a bit dubious about the use of computers ... that is becoming less and less. ... I am convinced that it is the way of the future. You can do things that not only look good, but are much faster and much more accurate. ... In the future a person can do it so much quicker ... it will lead to much more productivity and those people without those skills will not have the ability to use computers and computer information ... they will not be redundant, but not able to compete.

Carl sees computers as productivity tools, tools with such power that those lacking the skills to use them will be left behind. Our observations of his classroom indicate that persistent hardware and software problems have hampered his ability to use the computer system in his classroom, but this has not shaken his faith in the ideology of computer literacy. Harry Thorne echoes this faith:

I mean pretty near any type of occupation that you're gonna get into, having some knowledge on them and seeing how they can be used—not only just in computer studies or other courses that predominantly use them—I think the constant exposure to them, I think it's gonna be very beneficial to the students in becoming familiar with them, and learning how that they can use them in a number of different situations.

Here we see the more general form of the ideology of computer literacy, in which computers are viewed as a kind of enrichment resource, without being specifically tied to either technical or vocational education. These classroom observation records from both schools show, however, that the vocational message is being delivered clearly to students:

Discussion topic: labour market trends of the future. Based on *Globe* article. Trends: more white-collar, less blue-collar jobs ... big problem of the future is "lack of skilled employees."

Guest lecturer introduces video by saying that computers are the wave of the future in commercial art; students will need to know software to work in the shops of tomorrow (or today). Employers don't want to invest time and money into training; employees who already know the software are in demand.

The latter note comes from an Art class, but it is Commercial Art—a course with a clearly-defined vocational purpose. The argument presented has a double-edged quality: it urges students to acquire specific computer skills in school, because they cannot expect employers to provide it; at the same time, it implies that employers expect the school system to save them money by undertaking the specific types of training that they require for their businesses. This exchange with Ken Morton makes the vocational-push argument even more explicit:

Interviewer: To what extent do you think the kids in your class will be using these things when they leave school, say work-wise?

Ken: As I go around to industry, especially the two areas I get directly involved with ... I find that in all of these areas more and more are getting involved with an *AutoCAD* type of program. So that's one of the things they do. ... Yeah, there's definitely a relation to what they're getting here and what they're going to get in the workplace.

Interviewer: And those are kids who were selected into this class?

Ken: Well, these are computer technology classes....

This quote is from the teacher most directly connected to computer-related vocational training. He is teaching a computer technology class, aimed at developing skills for a defined marketplace. For such a class, it is not surprising that this teacher conducts his own surveys of local industry, and gears his classes to teach precisely the kinds of fluencies required by that industry. The only question to be asked, perhaps, is: to what degree has this model of secondary education permeated other, traditionally more independent, disciplines? Do all teachers presume that industry should define the curriculum, and that the function of the school is to respond to that definition?

The answer, in at least one case, is no. Alone among the teachers participating in our study, Walter Harvey had reservations:

> I don't care about this age of computers and everything else, I—excuse me for being old-fashioned—but a student should be able to sit down and write, maybe not legibly, because I don't, but they should write correctly. They should be able to communicate.

This teacher fears the loss of traditional literacy, the ability to read, write and "communicate" effectively, which may result from an over-reliance on computers. His resistance, however, frequently took contradictory forms. Its most potent expression was the simple fact that he consistently refused to introduce computer use into his classrooms, despite a good deal of pressure from various sources. His refusal, however, never took the form of outright defiance, and the verbal expression of reluctance quoted above was actually an anomaly. It was much more typical for Walt to attribute his lack of computer use to poor organization and a lack of time. In the same interview cited above, for instance, he said:

> I'm really interested in working with the OAC's on spreadsheets. That sort of grabbed me, and I'm really weak on that. It took me—when I was practising—a long, long time, but I just haven't worked at it, and I've just gotta, next Fall, buckle down and start—start doing it. For contrast. So I see a lot of super potential.

This teacher blames himself for not implementing computers in his classes, and significantly, he refers to the enrichment of his students' learning experiences, rather than market forces, when he expresses enthusiasm for their "potential". His other actions, and comments like that quoted earlier, however, lead us to believe that Walt actually felt that computers are *not* appropriate to his style of teaching and his educational concerns (see Paris, 1991, for similar examples). If this is true, what is significant is that he does not feel it is legitimate to openly express his opposition to classroom computing. The ideology of inevitability is so strong that he either feels compelled to accept it, despite his own reservations, or feels he cannot legitimately speak out against it.

Not surprisingly, the attitudes of teachers are frequently reflected in the attitudes of their students. Whether this is the result of the transmission of these attitudes in class, or whether both teachers and students are receiving messages from the mass media and other sources, is rather a moot point. What is surprising is that, among the large group of students who accept the ideology of computer literacy, there are pockets of students whose own experiences have led them to

question whether they will accept computers as an integral part of their own lives. This questioning can be seen to throw doubt on the assumptions that early exposure to computers is always a good thing, and that computer skills are built up progressively and cumulatively. For most students, however, the conventional wisdom regarding the future of computing is firmly in place. These quotations, each from a different student interview, offer a clear indication of its acceptance:

Student #2:	I just think they're a fact of life. I don't see them—I think they're gonna be just as common as televisions or whatever down the way ... . my husband and I have a business, so the necessity is coming ... . I have no choice, I have to learn how to use them.
Student #3:	In tech areas, I find that you have to have a computer knowledge. 'Cause everything is going more computerized by the minute ... understanding about when you get out into the work force, you—somewhere along the line you are going to have to deal with a computer ... even a car has a computer somewhere in it ...
Student #4:	I'm going to take a computer course, because—they're like, actually they're probably gonna be the thing of the future. The only thing that's gonna be useful.
Student #5:	I figure by the time I get into the work force, I'll need the computer knowledge, at least to an extent.
Interviewer:	And what do you plan on doing when you get to the work force?
Student #5:	I want to be, um, a teacher.
Student #6:	I just think they're useful, because they are going to become the future. Probably no matter what you do, computers will be needed.
Student #7:	Computers are really going to be more and more involved in everything you do and everybody should become familiar with them even if only in a very basic manner. Next semester I'll be taking my computers course... everything's getting so updated now you kind of need to know how to use a computer because everything is becoming computerized.
Student #8:	They're coming in, computers are in everywhere now so, I mean, people accept them as just another part of things, so why shouldn't they be part of your school too?
Interviewer:	I notice you're signed up to take a computer course next term.
Student #9:	I took it because we're going to need it in the future. 'Cause computers are going to be everywhere you go.
Interviewer:	Do you have some idea what kind of work you might like to go into?
Student #9:	Not really.
Interviewer:	But you're pretty sure it's going to involve computers whatever it is.
Student #9:	Well, yeah.

In these quotations, we see the full range of the computer inevitability thesis, and its expression in pedagogical as well as vocational terms. "No matter what you do, computers will be needed"; "everybody should become familiar with them"; in fact, they're "the only thing that's gonna be useful." Significantly, student #5, who plans on teaching as a career views computer literacy as essential. Even those with no specific careers in view "know" one thing, however:

"computers are going to be everywhere you go." This fact is so taken-for-granted that in the last quote, the interviewer's challenge of it seems to be considered a stupid question.

Of course, in many ways these students are correct in their perceptions. We cannot deny the ever-increasing presence of computers in society. The question for educators, however, is: what precisely are the implications for schools? Does the pervasion of the marketplace by microchips *necessarily* imply that they should also pervade classrooms? Or are the purposes of education sufficiently distinct that we should attend to other priorities? Will computer use be forced upon students, as it is upon workers, or will other options be left open?

In the face of the overwhelming conventional wisdom regarding the coming computer age, students who challenge the inevitability thesis are rare. Those who do so are likely to express themselves in confused, contradictory ways. Without a counter-ideology to support them, they find their personal reactions to computing in conflict with both the social trends going on around them, and the accepted notions of what a smart person should be doing to prepare for the future.

Student #10: Technology's fine and dandy with me, but I don't know, I guess some people are made for computers and some aren't. But, you know, like, I'm not—I'm not a person that's gonna say, "Well, you know, computers have, you know, there's no use for 'em", because I know, like, where I work, my boss, he does, you know, the files ... they just press a couple of buttons and you know, there you go .... I see that and that's great, like you know, if that's gonna help me when I'm—whatever job I go into, you know, that's great, but uh, I don't know, maybe just now, I'm young, and I'm naive, but I don't know. ...

Student #11: I like them, but I don't think people should get carried away with them. Because some of them think that computers are gonna take over everything. Well, they may, but don't get so adapted to them that you don't even want to go and get anything, you don't want to do anything on your own, you just—you want the computer to do it, you know. ... Don't get carried away with them.

Student #12: I think people should have a choice if they want to use them or not, like, if somebody stuck me on a computer, you know, I wouldn't want to do it ... . I just don't have the, you know, desire to, and if there's other people like me, I think that everybody should have a choice. I think it's great if they have computers in the school, 'cause I know there's a lot of people that love them, but ... I don't think they should be allowed in art at all ... Like, art is something, it's a feeling, and you can't type in a feeling on a computer. So, I don't think they should be in the art room, but that, again, is my—my choice, right, so...

The first of these three quotes expresses a simple and poignant confusion, the voice of someone who is just not sure where he will fit in. The others express a sort of general reservation, a sense that things are going too far, too fast, that there may be certain areas in which computers are not a good thing. They call for moderation, and the preservation of individual choice. They do not constitute a counter-ideology, but the fact that the speakers feel compelled to raise cautionary notes indicates that they feel a certain threat is being posed by the rush to computerization.

Students' attitudes take on other contradictory forms as well, as illustrated by this passage:

Student #13: I think it would be really neat if the whole school was done with computers ... I think they're worthwhile. I think they should be brought into the younger grades. ... I mean this is the computer age. Like my dad, he's been having a lot of problems at work lately, because they're trying to switch over to computers ... the guy comes home with the worst headaches, because he's worried about his job because he just can't understand them. And people aren't teaching him because they think he can't handle it. So, if you introduce them in younger grades ... People are just going to be—like second nature, it'll be just like writing or reading. ... I know my dad—my dad would like to get to learn—it's just, he's at work and it's hard for him. Because he's so stressed out, he just wants to learn it so bad, he's having the hardest time, you know... .

Despite her father's obvious distress at the hands of the computer revolution, this young woman feels that the solution to the problem is further education, both for him and for future generations. Clearly absent is any notion that her father, who works for a railroad, might have a legitimate right to resist the automation of his job. He, like everyone else, must develop a "second nature"—the ability to cope with computers.

Student #14: Come the 20th Century [sic], I guess, every machine's gonna be pretty well run by computer. But somebody's gonna have to rebuild the machine itself that the computer's gonna be running. So therefore you have to know how to shut the computer down, or to use the computer to move parts out of your way ... I'm a grease monkey.

This young man comes closest to expressing something which might be called traditional working-class pride. He uses terms like "grease monkey" in a defiant way, expressing a certain knowledge that, even if traditional machinists' skills are less in demand in the computer age, the society cannot run on information alone. Even so, he envisions a need for just enough knowledge of computers to be able to shut them down and get them out of his way. He does not resist the ideology of inevitability, but has developed his own coping strategy, which he feels will allow him to survive on more traditional forms of industrial-era expertise.

Students' resistance to the notion of a computerized future is often confused and contradictory, and their reaction to their own experiences with school computing are often similar. In some cases, however, it has crystallized into a firm anti-computing position. The first type of response is illustrated by this exchange:

Interviewer: You say you are going to go into a business career. Do you expect to use computers in the future?

Student #15: No, I didn't like my computer course.

Interviewer: No?

Student #15: No, especially the first time. I had a lot of trouble in the first half.

Interviewer: So you are not that keen, then really, on using them in the future?

Student #15: Well, depends on what it is for. If it's, like for work, no. This is fun. I don't mind typing in stuff and stuff like that but when it comes to learning about the computer I don't really ...

Interviewer: So you don't really care how it works or whatever.
Student #15: No.
Interviewer: You just want it to be easy to use.
Student #15: Yeah.
Interviewer: Do you think you will take any more computer courses or..?
Student #15: Probably. I'll probably have to. I'm working towards a business certificate, so, I think I gotta have a Grade 11 computer course. Whether I want to or not.
Interviewer: I see. so you think it's pretty well a requirement of the ...
Student #15: Yeah.
Interviewer: Yeah, okay. Well, aside from taking actual computer courses, would you like to use them, sort of like you did here in this class? As just, sort of, one feature of the course?
Student #15: Yeah. That would be cool.

Here we encounter a young woman in a virtual maelstrom of conflicting experience and emotions. Her introductory computer-studies course failed to indoctrinate her, and in fact had the opposite effect of putting her off computer use. By contrast, the more "casual" use of computers in her family studies course was viewed as fun. And, despite her avowed distaste for serious computer use, she feels trapped by her desire for a business career: "I gotta have a Grade 11 computer course. Whether I want to or not." She may be correct. She may have no right to aspire to a business career without developing computer expertise.

Not all student resistance is ambiguous, however. A few students have very strong feelings, both about computer use in society and in school:

Student #16: I don't like to use the computers. It's—well, what you can see, what's being done in society with computers I don't believe in at all, with the big rush for technology, capitalism, it's just all interrelated and I hate it ... like, manual techniques are a lot better than punching in at the front of a computer....
Interviewer: Okay, so you would prefer this course if it never included computers, or do you think it added anything at all?
Student #16: I didn't think it was really beneficial because most of the things we did were things we could talk about.

Student reactions to the concept of enrichment, or to the gradual accumulation of computer skills, also display of range of responses, as illustrated by this dialogue:

Interviewer: How about other uses in school...Have you ever had cause to use other computers in school?
Student #17: Yeah, I took, in Grade 11 I took a computer science course ... and so we did a lot of programming in that course.... So that was a quite difficult course actually, here anyways. Because one of the teachers is—he makes it difficult, I found. And I had a computer, the very beginning computer course in Grade 10. I can't remember what it was. ... and computer science, people won't take, cause, you know, people in school say,"Oh that computer science course is so hard." You know, that kind of thing.

What seems to be indicated by this quote, and by several similar ones which have reported negative reactions to computer studies courses, is that the assumption that there is a continuum of computer knowledge which is transferrable from one arena of learning to another may be false. Encouraging students to take computer science or business-oriented typing courses in the early years may, for some, actually be counter-productive to the development of attitudes and skills which will be useful in non-technical careers.

This evidence seems to point toward a number of possible new directions for educational policy. First of all, an effort could be made to ameliorate the ideology of inevitability. Realistic portrayals of future job markets would recognize that the number of high-tech jobs which will actually demand intensive computer knowledge will be a small minority of those available. Instead, a certain minimal ability to work with computers as tools will characterize the bulk of jobs that use computers at all. The implication of this recognition is that the integrated curricular use of computers is much more likely to simulate future job conditions than is a concentration on programming, or even on higher-level tasks such as file manipulation or database management.

More importantly, however, educators may wish to question whether in fact they themselves have accepted the inevitability thesis uncritically. Pressure from industry representatives anxious to sell computing hardware, from parents who think their children need to be equipped to compete both in school and at work, and from other teachers and administrators who want to feel that they are modern and up-to-date, may all conspire to push computerized learning into places where it does not contribute to the larger goals of the school. Educators need to ask themselves whether the vocational argument need apply to all subject areas, including art, geography, and English. They need to question the assumption that all computer training results in a smooth ascent up an imaginary ladder of skills. And they need to question whether students who find, for whatever reasons, that they do not get along well with computers, must be penalized for that distaste, or whether they have an equal right to a place in school and in society.

3.2 TEACHING STYLES IN TRANSITION

3.2.1 THE COMPUTER AS A TOOL: STUDENT

The topic of computerized writing was addressed briefly in our *Interim Report #2* (Goodson, Mangan, & Rhea, 1989b, pp. 22-24). That report was basically optimistic regarding the use of computers for students' writing, and the effects upon their learning experiences. Evidence gathered since then, however, has made us somewhat less sanguine on this topic.

Two major claims seem to be made regarding the relationship of computers to writing and keyboarding skills. The first is that keyboarding is an essential component skill which will open the door to more successful and satisfying use of the "computer as a personal tool." On this view, familiarity with a computer keyboard facilitates the operation of a whole range of computer programs: spreadsheets and databases, for instance, as well as word processors. It even makes the simple processes of logging in and using curricular software easier and less distracting. Therefore, this line of logic runs, keyboarding courses should be strongly encouraged if not required of students entering high school.

The second major claim is that using computers to write allows students to overcome many of the obstacles presented by handwriting, and allows them to write with greater ease and precision. Texts can be corrected, revised, edited, and manipulated more easily than when they are written by hand. Printed output is neater and multiple copies are easily produced. Skilful students can produce final copies more quickly than via any other method. The result is that students are more flexible about producing texts, write more, and take more pride in the final product when it is produced on a computer (see Dees, 1985; Baer, 1988; Owston, 1989).

Our evidence indicates that there is some truth to both of these propositions, but that the conditions surrounding normal computer use in the schools we have been observing mitigate these effects considerably. In order for the hypothesized benefits to be realized, a good deal more support of computerized writing would have to be provided than is presently the case.

3.2.1.1 Keyboarding

Keyboarding is generally considered to be a basic prerequisite skill for using computers. It is being taken by more and more first-year high school students, and is being introduced more widely into elementary schools. There is at least an impression among students and teachers that initial success with school computers is based primarily on earlier success in typing courses, or the availability of home computers. When they are asked to describe which learners do better on computers, the most common reply is "those who know keyboarding, or have other experience".

Interviewer: Do you think the computers work better with certain subjects, or certain grade levels, or certain kinds of kids than others?

Elliot: .... obviously the more senior students are probably more familiar with the keyboard, through home computers or through keyboarding classes. So that's one factor that has to be taken in.

Interviewer: Would you say that there are groups or types of students that do better or worse on computers? Have you noticed anything?

Student #1: .... I think everybody's pretty equal. It's just some people are faster typists or keyboarders or whatever. And they understand the computer more than some other people.

Keyboard skills are not only important to students. Teachers' own ability to become familiar with computers may be affected, as indicated by these observers' notes from the in-service training sessions:

> Teachers' keyboard skills vary wildly. Some people can't find letter key for their workstation. ...
>
> *Co-Co* workshop has taken over 2nd half of day. Exercises include: guess who, complete the story, make up an assignment. Lack of keyboarding skills seems to be real drawback to fluent use of this program.

In our interviews, however, we have encountered a surprising number of students who have taken a keyboarding course but report no positive effects. From interview transcripts to date, we were able to identify 41 students who said they had taken such a course and that it had helped them use computers, but another 17 who said they got little or no benefit from their course. Several students said they took keyboarding "just to get a credit", which indicates that they may have had no real interest in the subject, but felt pressured by course requirements, or by counsellors or teachers.

Other students said that they had dropped out of typing courses, or had received failing marks, experiences which seem unlikely to encourage computerized writing. It must be noted, however, that there were a few students who reported failing their typing course, but who still felt they had learned enough to be able to use the computer keyboard. These were fairly typical comments:

Interviewer:	Have you ever taken keyboarding or typing or anything like that?
Student #2:	Yeah, I failed it.
Interviewer:	Okay, so did that experience help you at all in using the keyboards here or did it not?
Student #2:	Yeah, I guess.
Interviewer:	A little bit?
Student #2:	It might have some effect.
Interviewer:	You've used a computer before in school haven't you?
Student #3:	Yeah. That was for keyboarding in grade 9 for a business credit.
Interviewer:	So, was that basically all you did was that keyboarding course—you haven't used them for any other purposes?
Student #3:	No, not really.
Student #4:	I took grade 9 typing. I got a good mark but that doesn't mean anything.
Interviewer:	No?
Student #4:	Like I don't know how to type.
Interviewer:	Really?.... So you haven't practised that much since then?
Student #4:	No. I just got the compulsory credit out of the way.

Of those who had taken keyboarding, most students reported using more-or-less old-fashioned typewriters in their courses. It seems that the teaching of typing has as yet changed very little to keep pace with technology.

The place of keyboarding as a prerequisite skill, then, remains very ambiguous. Many teachers and students see it as an important key to later success with computers; yet, among those who have taken keyboarding courses, there is a sizable minority who claim no beneficial effects

whatever. Still others cite failure in the course, but some acquisition of skills. From our data, there is certainly no clear and reliable link between keyboarding as presently taught in schools, and a general improvement in either attitudes or abilities regarding microcomputers.

3.2.1.2 **Writing and Word-Processing.**

Although keyboarding is often seen as a desirable skill in its own right, it is also closely intertwined with the idea of using the computer as a word-processing machine. In this context, keyboarding skills are only the first step in being able to enter, save, retrieve, edit, format, and print a text file.

Word processing is one of the most common applications of computers in schools. When students are asked what they have used computers for prior to taking the observed class, the almost universal reply is, "just to play games, and write stories." Most students, however, cannot remember what kinds of games they played, nor what their stories were about. These early experiences seem to have left little residual knowledge about concepts of word processing (although that knowledge may be present in some subliminal form).

In high school, many students also report that they have used the ICON system to enter notes or write a report. Teachers seem to feel that this is one of the most important "personal tool" uses, to which students need to be introduced.

> Yeah, the word processor I think is a real valuable tool for the younger students, and I think it's going to be a really valuable tool for the grade 13's. The grade 13's are inundated by essay work and project work, in particular with this independent study. ... It'll be interesting to see how much they'll use it. I think they'll use it a lot.

There is also another reason for urging students to use computers for writing, as indicated in this quote from Harry Thorne:

> I really wish all my kids would take keyboarding before they come in ... because some of their writing is atrocious. It would make it much nicer and easier to read and everything else.

By getting his students to produce clearer writing on the computer, in other words, this teacher's job would be made easier. He could concentrate on evaluating the content of students' compositions, rather than the task of deciphering their handwriting.

The doctrine that neatness counts is alive and well, then, and influencing the use of computers for writing. Carl Higgins went so far as to tell his students that "You can write the most incredible poop and if you do it on the computer, you'll get a mark. It's the difference between an A and a B." Chuck Grambling has cited computer output as a "great equalizer"—i.e., it encourages the teacher to attend to the content of written assignments, and removes prejudices engendered by sloppy presentations. Students tend to agree; one said of computer writing, "It looks neater. It gives you a better appearance ... it looks more formal." Another student said during an interview that his science teacher gives two marks for neatness in lab write-ups, and for this reason alone, he always uses the computer for such assignments.

Despite this general emphasis on the importance of word processing, the introduction which students receive in most classes is so abbreviated that their reactions are, at best, mixed. Although many students are attracted to word processing, some say they would not use computers again voluntarily to produce written work.

Student #5:	As I said, I can't—not really that good at typing, and ... got really, like, bored with it. Keep going back to the computer room.
Interviewer:	Right. Would you prefer to have just written it out by hand?
Student #5:	Yeah. Absolutely.
Interviewer:	Do you think a lot of your classmates feel the same way?
Student #5:	I'd say it'd be about half 'n' half.
Student #6:	Every time I used them, the ones in our family studies room, trying to save it I always lost my work.
Interviewer:	Oh no!
Student #6:	So you had to type it out again, and waste a lesson. ...
Interviewer:	And how did that make you feel? Like were you. ...
Student #6:	Awful.
Interviewer:	Awful, I guess.
Student #6:	I didn't like those computers at all.

In a similar vein, Dees (1985) found that introducing students to computer writing exercises without prior keyboard training reinforced poor habits, and "created difficulty when the student subsequently enroled in a typing course." (p. 22).

Despite these problems, most students express a keen awareness of the benefits of word processing. There is nearly universal agreement that computer-printed writing looks "neater", "more professional", etc. (although there are a few mavericks who dispute this).

Student #7:	I would never type out a report or anything on the computer and have it printed out.
Interviewer:	Why not?
Student #7:	Oh it's just, there's nothing like having a typewriter, the print on a typewriter. It's, I mean it's ink and you got the nice solid letters, not the little tiny dot matrix making letters and I don't. ...
Interviewer:	So your first choice would be to do something on the typewriter?
Student #7:	Yeah.

3.2.1.3 Writing in the Context of Subject Subcultures

The effects of subject subcultures, so often cited in these reports, also has a bearing in the area of computerized writing. Most of what has been said applies more to traditional "academic" subjects, e.g., English, history, geography, etc., than to "practical" subjects such as art or drafting. Students in art did not feel any lack of keyboarding skills to be a deficit, as they work almost entirely with the trackball and Action key. What lettering there is to be done in art is usually brief, and both teachers and students appreciate the ability of computers to relieve the drudgery of hand-lettering, as indicated by these interview extracts:

Wendy:	graphic art runs all the way through the program. Well, a computer's perfect for that. Why are we doing all these little hand-lettering exercises, when we could have a print-shop package that would do a lot of that work for us? It's the difference between doing math by hand, or math on a hand calculator, y'know?
Interviewer:	How do you think your art would be different if you didn't have computers?

Student #8: I'd have to do an awful lot of lettering by hand.
Interviewer: Yeah? So, it is good for that?
Student #8: Yeah. ... I think out of our class, there's only one girl that still does hand-lettering.

Even if a majority of students like computer output, however, there is serious disagreement as to whether word processing is also a labour-saver. Many students cite word processors as making document production faster, easier, etc., but there were slightly *more* who said that the nice-looking output of word-processed documents was harder and/or more time-consuming to produce than hand-writing.

Interviewer: Why did you choose to do it on the computer?
Student #9: Neater. Yeah. Took me a lot longer, though. One finger.
Interviewer: Was it worthwhile?
Student #9: Yeah, I think so.
Interviewer: You don't find it frustrating, if it takes you longer?
Student #9: No, it's—just trying to get used to everything on there, because you just—we didn't have, like, long to learn everything, so. ...
Interviewer: Right, yeah. ...
Student #9: I'd forget everything by the time I went to type it up.I think using the computers screwed us up.
Student #10: I'm not a typist, so it takes me too long. I get frustrated, it takes me a lot longer. I don't like the computers. I could have written out the project in one period.

3.2.1.4 <u>The Demands of Word Processing as a Personal Tool</u>

What all this seems to point to is that the benefits of using computerized word processing as a personal tool are only realized after a considerable period of training. A repertoire of skills must be built up which includes not only the psychomotor functions of typing, but a complex conceptual structure of words, sentences, paragraphs, documents, and files. In addition to these concepts of document construction, there are a number of specific word-processing conventions—and accompanying vocabulary—regarding operations such as cut-and-paste, spacing, justification, pagination, special features, and typefaces. The menus which appear on a *WPro* screen are a good example of this challenge.

Student #11: What does "justify" mean? It says "justify" and I tried justifying once and it screwed up my whole thing, the whole lines went. ...
Student #12: like with a typewriter you just hit it and you know, slide it, it goes to the next line. I hit the wrong button somehow and it just went "psfft", erased everything ... and I had to do it all over.

Simple "introductions" to word processing seem to do little to encourage students to use computers for their own writing. Most students recognize the potential for improved editing capacities on a computer, but there is little evidence from this project (or, for that matter, from other more intensive writing projects) that students' writing abilities are significantly improved by just being exposed to computers.

There are other facets to computerized writing which deserve consideration. For instance, the generally superior abilities of female students in word processing may act as a counterweight to

the predominantly masculine culture of computing. Word processing and spell-checkers may also have the potential to help learning-disabled students. As indicated in this quote, though, that potential is not yet realized in the present state of the art.

> I had a student who has a special learning disability—I think he's dyslexic—I'm not sure, and his spelling is so bad that the word, that the spell checker can't recognize anything. And his, you know, when he tries to use it it's just a disaster. But at the same time he's quite willing to sit there and peck away and work away. This particular student I think would do that in any event. I don't think the computer is any particular asset, although it may be faster for him than his own writing, and it's certainly clearer when it's printed out, but his spelling is the sort that if you don't read it aloud, you don't understand it. I mean, literally, you just don't, it's phonic—I mean it's, yeah. And so, I found that limitation. ... Very good student though. I mean he got 70% plus in course work if you don't take into account spelling and so on, which I didn't in this case, of course.

3.2.1.5 Implications for Future Computer Use

If a really serious effort is to be made to equip students to use computers as personal writing tools, it would seem that several steps will be necessary. It would probably help if a single word-processing package could be chosen as the standard, at least for introductory use, and this package would be used exclusively during the first year or two of exposure. Keyboarding courses must also be integrated with other word-processing functions. Opportunities to practice, and rewards for applying that practice, should be built into the system. Portability of files within schools, and between schools and homes, should be improved. Also, a full-term credit course virtually demands that complex topics in composition and business practice be introduced, in order to give the course "substance" and "rigour." If the intention of introductory keyboarding courses is to prepare students for more adept computer use, however, it would seem logical that they be made shorter, and perhaps not for credit. It would also seem sensible to use computers rather than typewriters to teach such courses, and to introduce topics more directly related to students' needs, such as note-taking and essay writing, rather than topics in business.

In the absence of steps such as these, the partial and piecemeal exposure that students are presently receiving may be acting to discourage as many students as it is enlightening. In the process, it may be having the effect of creating differentially-privileged classes of students who can and can't use computers. We have provided evidence that students and teachers believe that prior computer use is an important condition for secondary-school success. If these impressions have any merit, if home computer use and/or the acquisition of keyboarding skills are the keys to successful academic computing, then students—and teachers—who lack these characteristics are being placed at a disadvantage. The uneven quality of introductory computer use means that access to what has been identified as an important tool for future success in both school and paid work, is being conditioned upon some fairly arbitrary criteria.

The creation of differences among the school population is not by itself, of course, a bad thing; in many ways, all schools function to produce differential skill levels in students. The question is whether the system is doing everything possible to create equal opportunities for all students to benefit from their school experiences. This is what we take to be the meaning of the slogan of the Board of Education for the City of London: "Success for every student." There may be little that schools can do to remedy the unequal distribution of home computers and other

technological advantages. But there may be a great deal that could be done to make school computers more accessible, and to better equip students prior to high school with the prerequisite skills which they will need to take full advantage of that access. The comments cited above indicate that many students consider current keyboarding courses to be onerous or irrelevant to the rest of the curriculum. These are probably the very students who could benefit from an encouraging introduction to computers, as they tend to be the ones who identify others as having skills and opportunities which they lack.

One thing seems clear: For any of the benefits of computerized writing to be realized, there must be a more thorough integration and solidification of skills across the curriculum. Given the admitted preference of teachers for computer-produced output, access to word processing as a personal tool may already be an important factor in academic success. The importance of this skill militates against its haphazard distribution.

3.2.2 COMPUTER USE AS A TOOL: TEACHERS

The teachers in this project have used the computers for a variety of classroom management purposes, as outlined in the Principal Investigator's report by Allan Pitman in Volume 2. These uses included: the creation of classroom handouts, memos, and letters on a word processor; the use of spreadsheets; the use of marks management programs; and the creation of presentation materials.

The teaching styles of these teachers have also been in transition as a result of the use of computers: the specific use of computers as a **tool** to aid in their teaching process was repeatedly noted by the teachers. They referred to this tool use in a variety of ways, including: a tool for teaching and learning, a tool for the future, and a tool for increased speed. Each of these will be discussed in the upcoming pages.

Most frequently cited by the teachers was the use of computers as a tool to better teach their subject. This includes the introduction of a new medium, another way to reach students with different learning needs. As this teacher said, it is also a way to capture their attention and to motivate them:

Interviewer: So have the computers changed your subject area at all? Like what you teach or anything like that?

Harry: I don't think it has changed **what** we teach but I think what it has done is, like again, I stress, it has given us another tool to do our job. I think that it gives a little more...a different twist on...a little more interest to a lot of the kids. It is something else to use instead of just using a book. It gives you a variation to teaching styles. I think it is necessary. Especially today...you have to entertain the kids more today than we used to twenty years ago, thirty years ago, so it is another entertaining tool that is very useful.

This method of reaching a variety of students was seconded by Carl in an interview as well, in a discussion of learning styles in students:

> I see computers as a tool, I don't see them as being the centre of the program. I see them as being an aid...an aid to the program. In a different way, a different strategy for learning perhaps, but no different to any other strategy that I might acquire. Like I think

the computer helps a teacher reach certain students, you know this right-brain, left-brain thing.

Harry also further developed his earlier statement with a comment on the development of his teaching style, allowing the students the opportunity for more independent learning with the introduction of computers into his techniques:

I think any time you bring a new medium in...it just adds to your style. I don't really believe that it changes my style a whole lot. I maybe let the kids do a little bit more on their own than they used to.

and on another occasion,

...there must be some people in the teaching field at that end of it that are still not convinced that computers are a useful tool. And I see them as that...as a tool. They are not the be-all or end-all. They are a tool that we can use to better do our subject. I don't see any problem with most of this changing.

While teachers feel on the one hand that computers can be used as another tool to better teach their subject, it is also strongly felt that they are no more than that. They offer one more means to learn, one more addition to their "bag of tricks", and several take this approach in their teaching with their classes, as Barb said:

So what I try to teach my students in the class is that the computer is just another tool or another medium. Maybe I try to give them a proper perspective as to how it should fit into their daily routine. So they don't end up in, say, a job that I ended up in, that was purely computers. That's what we did, was work on computers eight hours a day. It's crazy and the thing is, that those businesses are now going under because the computers and their capabilities are now available on the PC's, so...

The following observer's fieldnote further develops this notion of computers as one more tool in the classroom:

Elliot seems to be incorporating the computer into his classroom without much ado. Today when I was in his room he had some students using the computers, while others were watching a video, cutting things from magazines, working in the library, or involved in small group discussions. He is using it as another tool in his classroom, not something that is taking over his entire teaching strategies.

and in the art classroom:

Interviewer: So you think computers should be used as a tool then, as one other way to understand art or to experience it?

Wendy: Yes, and as a like a total life thing for them to use computers in their, everything they do. I think it's important that's in art also, but I don't see it as replacing the old-fashioned way of learning art.

This concern for replacement of "old-fashioned ways" and replacement of teachers is something that seems to be on the minds of many teachers, but was more frequently disputed by the participant teachers in our project, based on their knowledge and familiarity with computers. There was no longer a fear of the unknown:

Barb: I guess I am trying to find out things for my students. I find out where it is good for me, and where I just can't be bothered with it. And it's really funny because some of these people are so petrified that it's going to take over their jobs. But I really don't think that it will. As

time goes on, and especially the more exposed to it, you realize it never will take over jobs, because there's still many things you want to do by hand.

In general, computers were seen to be an excellent tool for teachers, not only in terms of a learning tool, but also in terms of completing the other various tasks expected of teachers, freeing up time from such time-consuming activities that could be used for other purposes:

Barb: Of course I've used it in different ways, that probably nobody else would've thought to use, [laughs] they think, "Oh we can use these computer images". We're actually probably going to do up some images for the fashion show, to be projected and just colour and make slides from the printed hard copy, 'cause it's so quick, instead of sitting down and painting all those things, "Oh let's make up some really neat textures it's, 'cause it's just going to be colour and form, and we'll do a printout and then we'll make slides from them and project them", you know, so why not?

Interviewer: Sure that's what, that's what they're supposed to be for, for one of the reasons, just to free you from time-consuming tasks.

Barb: That's right.

Interviewer: That's one of the ideas, it's not just for, you know storage, or not just for other things.

Carl used the computers for a great deal of his writing:

Carl: I mean I very rarely write anything by hand now, they're almost always done on the computer.

Interviewer: And I find it painful when I have to do it.

Carl: I do too. It irritates me because I know that the end result is so much better when it comes from a computer. And I've got a record of it. I can go through the iterative process one goes through in writing much faster with a computer. So I find it irritating doing it the old way because it's obvious to me that the new way it's so much better. Now whether I think that it's better to use a computer assisted learning package than sitting down in front of a book and drilling that stuff in there into my mind in the old way, I'm not convinced that that way's not just as effective. However, you know that right-brain, left-brain multiple ways of learning approach, the computer assisted learning may be better for some people.

Interviewer: Another way to catch on their students.

Carl: Yeah, sure.

Interviewer: To maybe using other ways.

Many of the teachers have become very involved with the use of computers in their classrooms and are appreciating their uses both as a tool for their students as well as for themselves:

Interviewer: OK, well in general, are you optimistic about the use of these computers in the schools in the future, or where do you think it's all heading?

Wendy: I think it's a wonderful idea. I feel very optimistic about it. It's an addition to the art room, a very valuable addition, and I hope that they let us keep them, and they get to be a regular part of the art program here. I'd be disappointed if they took them away, and I think the students would be too.

Interviewer: Is that a change in attitude from the beginning of the project, or were you fairly, reasonably, favourably disposed?

Wendy: I suppose I was favourably disposed towards them anyway. I had seen some things done in computer graphics that I really admired, and I thought that the ability to use a computer to do those things has got to make any art room better. It's got to be a wonderful tool for a teacher.

This tool was seen to be an enhancement not only for teaching, but for learning as well, as stated by Diane:

Interviewer: So do you see it just as another tool to learn or is it actually you're learning differently or something else with it?

Diane: I think you're learning perhaps more effectively in my case. They would do a much better job on the computer than I think they would do handling mathematical things by themselves. I know that a lot of them are working at grade 4 level in math for example and there's no way they could have analyzed their diets without using the computer. And yet they were able to do that and to actually see the results and to get accurate results because they were using the computer. So it did allow them to do things that I don't think they could have done as well, on the computer, you know if they did it by hand. But just being out of the classroom I think and into somewhere else was really a good experience. Being on the computers and their interaction was a really excellent experience for them. I don't know, they just seemed to really enjoy it, they really seemed to enjoy it overall.

This use of computers was also seen as a tool to increase speed of work completion, both on the part of the teachers as well as the students. Teachers had mixed reactions to this, for on the one hand they were freed from time-consuming tasks, but on the other they found that more was being expected of them. Barb speaks about this in the following interview excerpt:

Barb: And I guess a lot of the times, when I was working on computers, I kept going, "Okay, you know, I want to use the computer because it's the latest in technology and I can get my work done faster." The thing is, they give me even more work to do now. So when does this all end?

Interviewer: You can do it faster but you have to do more. Yeah.

Barb: Yeah. It's like, well, yes, we can do this faster but our lifestyle is becoming more stressful because we...'cause now you can do it faster. So that means we can do more.

Carl, however, sees the computer as being used as a tool to speed up rather than enhance learning, while being much more than a "super pen":

Interviewer:	So you think the role for computers is a tool?
Carl:	Yeah I do, I really do. Like I mean it's much more than a super pen, I mean I heard people compare it, the computer to a pen, I don't see it that way, although it obviously is used there. I see it as an extension of the human brain. It's just a faster way of dealing with things. Computing for example, I mean a hand calculator is so much faster than a human being working with log tables. Do you remember log tables? [laughs]
Interviewer:	Yes, I remember them well.
Carl:	I worked as a surveyor out in the field, that's all we used were well...ten figure logs and it was really tedious. Just as a calculator was a godsend, so is the computer.

and on another occasion,

Interviewer:	But there's also other people questioning whether if computers are just going to be another tool. I'm not sure if the word 'just' should be there, but anyway if computers are 'another tool' is it worth the cost involved if they're not going to completely revolutionize learning or teaching or something like that, is it worth the cost?
Carl:	Well sure, because it makes us more efficient. Yeah I really feel that's true. I'm not sure whether they enhance learning, I have yet to be convinced of that. I think you learn in a different way but whether that is, whether that is better than the old way I am not sure.
Interviewer:	So while you feel that they may not enhance learning what is their role then to, to speed up learning?
Carl:	Yeah, to speed it up, right.

In any case, the teachers agreed with the students' views that computers were going to be very important in their future lives, and that they must become comfortable with these tools for the future:

Interviewer:	Do you think that all students need a certain level of computer expertise?
Harry:	I would think that any extra tool that they...going out into the working world is going to help them. They have a certain expertise in computers...I don't think there is going to be any facet of our society or even our home life that won't involve computers at some stage. And I don't believe ever that they will take over completely at this point. They are, I believe, a tool. And they will make life a little easier, a little more bearable.

and by Wendy on another occasion,

They all use computers everywhere for in their jobs and I think it's going to be a big part of the future and if they have it in every classroom, something they get comfortable with and learn to use easily and they will be able to take it further than I will because if they've had it for a long time, from very young till whenever they graduate, they'll see possibilities that I can't see. I have a mind that can only see so far because it's a new

thing to me, so they will, they will solve a lot of problems themselves. They'll use it as a more effective tool than I will.

Thus, we can see that teachers see the use of computers being used as tools, transforming their classrooms in different ways. While these changes may not have been as revolutionary as might have been expected, changes have occurred in every class. In some cases, it is seen as one more method of reaching their students, in others as a way to improve the speed of learning, and in ways of presenting material to the students. In all cases, however, regardless of the level of change, teachers have responded positively to this change.

3.2.3 THE COMPUTER AS MOTIVATOR

One of the most consistent findings from evaluation studies of computers in education is that the use of computers increases students' enthusiasm for school, and results in more positive attitudes towards computers in general (see Kulik and Kulik, 1987). Our study has generally found similar reactions among students. As mentioned in the section on student profiles in Volume 1, for instance, roughly three-quarters of the students in both schools generally expressed positive attitudes about computers in education. Many of the students commented in interviews that they enjoyed using the computers in class.

One of the strengths of a qualitative approach, however, which emphasizes the treatment of participants as individuals, is that it is possible to probe those individuals a bit more deeply as to the nature of their reactions to computers. Unlike statistical analyses which tend to reveal only the central tendency within a sample, interview data can expose the character of and the reasons behind the reactions of the minority. The Ontario school system has, for several years, indicated its sensitivity to students with special needs. The implementation of computers in classrooms should also attend to the voices of those who may be less than enthusiastic about the computerization of their education.

Students have generally reacted very positively to the introduction of computers in their courses. For instance, when asked for their overall reactions in the first round of interviews, only five students of the 32 who responded gave negative comments. In response to a question on the difficulty of using the computers, only two students reported having extensive problems with them. Two others refused to use the computers, and four reported initial difficulties that were overcome with practice.

Most students said they enjoyed using computers, and regarded most computer use as in some way "fun". Some even said it was "just playing games." Several indicated that computers improved their motivation, both to do writing assignments and to experiment with other software. Several expressed a wish to have a computer at home. This could be a very positive feature, if it indicates that computers have made real learning fun, but it may also indicate that in fact there is little educational content to some software.

The teachers in the project have not failed to notice the motivational effect of classroom computing. Chuck Grambling, for instance, regularly schedules computer-use sessions for times when he suspects student interest might otherwise be flagging. He reports that he has found this to be a successful strategy. Elliot Nance and Harry Thorne, the social studies teachers at Tecumseh, have described their use of the computers as "enrichment resources", by which they seem to mean that they can be used by students for extra-curricular activity, after assigned homework or seatwork has been completed. This activity is frequently characterized by students

and teachers alike as "playing around with the computers", but its educational value should not be assumed to be low. Both of these teachers report that the prospect of using the computers is a motivator for some students to complete their assignments, but Elliot has also reported a negative effect of *over*-enthusiasm: some students rush through their class work and complete it sloppily, in order to spend the remainder of the period in free computer use.

In contrast to this general level of enthusiasm, there were also a few students who were negative about classroom computers. Interestingly, these students seemed to have strongly formulated and articulated positions. For instance, the two female students at Tecumseh who chose not to use the computers during the first observation term were very serious about school, and voiced opinions on computerization such as "It's a way for lazy kids, you know, to do nothing." These students saw the computers as impediments to their achievement goals in school. Other students admitted having difficulty, but they were not opposed to computer use in the same ways these students were.

Student comments indicated that the ideology of computer literacy is firmly established. The resistors mentioned above were somewhat less enthusiastic than most, but in general students strongly endorsed the notion that computers were the wave of the future, a necessary requisite to future job attainment, etc. Most welcomed the opportunity to obtain the skills necessary for such a future. At times this attitude seemed paradoxical: one female, who was very clear about the negative effects of computerization on her father's job and life, nevertheless said she did not regard the general trend toward computers as lamentable.

It is clear, then, that there are students who object to using computers, on what we consider to be valid grounds. Some have expressed an understandable degree of intimidation and fear, which might be overcome through practice. Others, however, have said that they consider school use of computers as presently configured to be a distraction from their more important goals within the courses they are taking. Some art students at Brock, for instance, have expressed the opinion that computers were not well suited to the expression of artistic values, and that they served to stifle the creative process of interaction between artist and medium. Even if such opinions are held by a small minority of students, they pose a challenge to the equity of computing policy. Can such objections simply be ignored, or should provisions be made to accommodate them where they arise? It may also be the case that they constitute less of a minority position than is initially apparent. Since students have been presented with a *fait accompli* as regards computers in classrooms, it is conceivable that the minority of vocal and articulate opponents is the tip of an important iceberg. Several students have indicated that they would like to see free choice within the school, to use computers or not. To the extent that this can be considered an informed and reasonable decision, it should probably be respected.

3.2.4 THE DESIGN OF THE COMPUTING ENVIRONMENT

Many topics related to the implementation of microcomputers in schools can be considered from a purely technical point of view, i.e., how they affect the teacher's lesson plan, the test performance of students, or the time spent in class. We recognize the importance of these considerations, within the context of evaluating the technical adequacy of a new system. The perspective we have been advocating, however, suggests that we should look at some topics as having an impact, not only on the practical aspects of computer implementation, but on the social structure of the classrooms, the school, and the learning experiences of the students involved.

Perhaps the most striking example has been the effects of the contrasting physical installations of the microcomputers at the two participating schools. Researchers' observations indicated effects on the social interactions both between teachers and students, and perhaps more importantly, among teachers with each other. In the first report by the Board's liaison, Peder Nielsen (reproduced in Volume 1), he described the differences in the two schools' installations as follows:

> In order to research the pedagogical impact of computer configurations, Brock was equipped with a laboratory networked configuration. In this arrangement one room was set aside as a dedicated laboratory which can be reserved by the project teachers.... The physical design at Tecumseh, however, consists of a few computers placed within the classroom of each project teacher.... In such an arrangement, the teacher needs to be sensitive to activity-centred learning strategies.

In this description, the hint of a research hypothesis is evident: the physical arrangement of the computer workstations will have an impact on classroom pedagogy, with the predicted direction favouring "activity-centred learning strategies" in the classrooms which have on-site workstations. Some comments on this hypothesis are presented below. The main strength of our research methodology, however, was that it allowed field observations to go beyond this hypothesis, and to record other, unanticipated effects on both classroom organization and participants' social and professional interactions.

One fact which had observable effects was that the two ICON installations did not constitute a completely controlled situation. In the Art room at Brock, a single Apple MacIntosh computer has been in place for some time and has become a central feature of Barb Cunningham's lesson planning. In addition, several students had been exposed to other types and arrangements of computers in other classes. Although the distinctions between these computers and the ICON installations were clear to researchers, students often mixed them together when answering questions in interviews. The importance of the MacIntosh to the Brock Art curriculum, especially, made it the focus of several students' comments regarding school computer use.

Also at Brock, the location of all workstations in a single lab had a number of unanticipated consequences. The first had to do with the fact that teachers had to leave their accustomed classrooms or offices to go to the lab in order to do computer-related lesson preparation. This meant that they always had to go to another room to do any hands-on testing, taking with them any materials they may need. This fact may have acted to inhibit experimentation and familiarization with the equipment on the part of at least one teacher. Similarly, any class trip to the lab involved organizing students for a trek across the large school building which often took ten minutes of the period before all were settled. These "costs" of using the lab may have acted to discourage teachers from using it more often.

When teachers did go to the lab during school hours, they often had to share the lab with another teacher's class in session, and to tolerate the associated noise and activity around them. At one point, Ed Thompson, who had been doing lesson preparation, was forced to sit, for about 15 minutes while another teacher did a demonstration on the Robotel, which takes control of all users' workstations.

Another effect which could have been predicted was that there were frequent scheduling conflicts. As Chuck said during the second observation term, "Everyone wants period 4", due to timetable overlaps. Fortunately, conflicts were handled amicably through a negotiation process.

A policy has also evolved regarding use of the lab outside of scheduled class times. Essentially, it is open when not booked, but only if at least one teacher is there to supervise. Some teachers have established regular, supervised lunch hour sessions. Others have set up *ad hoc* sessions for students.

A more serious conflict arose after the fourth period of observation, however. Prior to the project, the room referred to in these reports as "the computer lab" had been a student art gallery. Its conversion to computer space was not met with universal enthusiasm, especially among art students, who lodged both formal and informal protests over the loss of their display space. As a kind of compromise, the computer lab was returned to control of the art department for two and a half days a week at the end of the classroom observation period. Art history classes were scheduled during this time. Unfortunately, this resulted in a new set of constraints being imposed on the teachers who had incorporated lab use into their teaching routines. There were even rumours that the lab would be dismantled, and that the computers would be incorporated into existing lab space in the computer studies department. This development illustrates the impact that the installation of computers can have on the "geo-politics" of schools. In schools which are often already overcrowded and under-funded, the allocation of large chunks of classroom space cannot be expected to proceed as an uncontroversial issue. The requirements of computers for supporting resources can exacerbate competition and conflict among staff and departments.

Fortunately for our project, and for the school, the participant teachers generally acted calmly and creatively to solve problems such as these as they arose, and it is probably a tribute to the healthy working relationships within this school that there were few bureaucratic brush fires over these issues of access. The solutions arrived at also reflect other aspects of the background of this school board, however. The policy regarding free-time usage, for instance: it was naturally assumed that the lab must be locked when there was no teacher in attendance. However, at the "lighthouse" school we visited in Belleville, Ontario, there was at least one lab which was left open to students without supervision.

Policy and design can thus be seen to interact to produce different situations at the two schools, which in turn affects student use and interaction related to the systems. At least one Brock student mentioned restricted access to the lab as a hindrance to the completion of his assignments. At Tecumseh, on the other hand, there was open access to the computers in the library, and the classrooms containing computers were usually open and staffed for some time before and after school. At this school, students showed more of a tendency to come in on their own time and "play" with the system. Students reported that they used these informal sessions to share expertise, to experiment with creative tools such as *Spectricon*, and to explore the range of software available.

The computer lab at Brock had a positive effect, though, in increasing the social interaction of the participating teachers. They found that they ran into one another frequently in the lab, and engaged in more peer consultation and sharing of resources than they would have otherwise. Chuck commented that "it's not unusual to see four or five of us all in there at once, just exploring, getting something ready, and that's where an awful lot of communication flows back and forth."

To recognize these social effects is not, however, to deny that there have been observable differences in the pedagogical uses of the computers, as was suggested in the first report. The relatively large number of workstations in the Brock lab has meant, for instance, that there is no

necessity for student collaboration, although both research and Ministry guidelines have suggested this is frequently desirable (see, for instance, Carmichael et al., 1985; Heap & Moore, 1986; Ont. Min. of Ed., 1991a). Each student can usually have his/her own workstation. As a consequence, there has been less impact on teaching styles at Brock than at Tecumseh. Some teachers have tended to transfer their teacher-directed, uniform-activity classroom style to the lab. Some teachers at both schools, however, have said they recognize that opportunities exist for a different style, and they are working on lesson plans incorporating such a change.

At Tecumseh, where there are three workstations to a room, the physical environment varies from room to room. Especially in the art and drafting rooms, where a separate storage area is used to house the computers, the environment tends to be cramped, cluttered, and poorly ventilated. Nevertheless, its separation from the rest of the class by a glass wall may be an advantage. In the social studies classes, the constant local presence of the workstations has allowed the teachers to permit voluntary, casual use of the ICONs during class time. Since it is not necessary to organize students to go to another room, students can be allowed to schedule their own time on the computers.

The design of the computer installations also tends to interact with some of the technical problems experienced. None of the installations in either school really has proper furniture, but the tables and chairs selected for the Brock lab are superior to the generally undersized and awkward desks at Tecumseh. At that school, the failure of one workstation can result in the loss of 1/3 of a class's available computing power, versus only 1/20 in the Brock lab. Substitutions for malfunctioning equipment are easier in the lab.

Technical difficulties cropped up most frequently in the Brock lab, where the simultaneous access of the system by up to twenty pupils frequently caused it to bog down. At Tecumseh, on the other hand, one piece of particularly troublesome software, *Spectricon*, was in heavier use than at Brock, and thus caused more frequent crashes during the first two terms of observation. A later version of *Spectricon* proved to be more reliable.

Teachers at Tecumseh have responded to some of these limitations, and have quickly evolved a pattern of sharing; students with computer assignments can often go to another teacher's room where there are computers and "borrow" them. Tecumseh also has workstations available in the library, which some students reported using outside their classroom time to complete assignments.

The physical design of the computing environment can thus be seen to have a number of effects on both the technical performance of the system, and on the coping strategies and social interactions of students and teachers. No one design has emerged as ideal; most teachers now say that a lab would be good for introductory sessions, while classroom clusters would be better for later lessons. The Tecumseh art room provided perhaps the most favourable mesh yet observed: the layout of this room allowed the computers to be nearby, but separated from the main class by a glass partition. The computers were thus neither intrusive nor distant. The choice of open-ended software, combined with the teacher's coaching style, produced a fairly natural-feeling integration of CAL. Such a happy combination may more often be the exception than the rule, however.

3.3 CLASSROOM INTERACTION ANALYSIS

3.3.1 THE DEVELOPMENT OF RIACPTS

Over the course of the project, the RUCCUS research team accumulated enough ethnographic classroom data to allow for what we felt was a fairly accurate characterization of the atmosphere and teaching style prevailing in each participating teacher's classroom. However, the observational style we had employed during the first three semesters of data-gathering did not allow for accurate quantitative estimates of either the extent or the character of classroom computer use. We therefore decided to switch the focus for the last term of observation towards an attempt to collect such estimates, subject to the limitations of our resources.

To accomplish this, we employed two basic techniques. The first was a computer-use journal, covering the entire fall semester of the 1990-91 school year, which we asked all participating teachers to complete. The second was a system which we developed for tabulating observed classroom activity on two basic dimensions: interpersonal interactions, and *level of cognitive function*. This became known as the "RUCCUS Interaction Analysis/ Cognitive Patterns Tracking System", or RIACPTS. A facsimile of the scoring sheet for observations made using this system is presented as Appendix 1.

In our first interim report, we referred to the long tradition of efforts to categorize the nature of classroom interaction, and computer use, along cognitive dimensions (Goodson, Mangan, and Rhea, 1989a, pp. 24-27). We stated our intention to move beyond these efforts by attending to important social dimensions as well as to individuals' cognitive patterns. "We are interested in the impact of educational computers on basic issues of pedagogy and the organization of classrooms, as well as their efficacy as learning resources within the secondary school curriculum." (ibid., p. 26).

The RIACPTS scoring sheet is essentially an attempt to test the possibilities of this approach. We began by developing a typology derived from cognitive categories defined earlier by Bloom et al. (1956/1972), and by the UNCAL project (MacDonald et al, 1977). By combining this with the kind of interaction categories originally developed by Flanders (1970), we designed a two-dimensional grid. Brief definitions of the kinds of activities which fall into each category are included at the bottom of the scoring sheet.

Observers made use of the scoring sheet by making simple tic marks in the boxes defined by the intersections of the categories. Each mark summarized the main activity observed during successive 30-second periods of classroom instruction. In addition to these marks, researchers also classified the observed activity as pertaining either to the class as a whole, or to a small group of students or an individual. The result was a series of counts, which were later converted to proportions, presenting a picture of the total pattern of classroom activity during one lesson. Written notes were also made describing any problems or unusual activity in class.

A total of forty-nine RIACPTS observation sessions were conducted. Of these, four sessions (each in a different classroom) involved simultaneous coding by both observers, as a means of assessing inter-rater consistency. Three of these sessions were included in the final data tallies, but weighted at 0.5 in order to avoid double-counting. One of the simultaneous observation sessions was excluded from later analysis to compensate for an over-sampling of one teacher's classes. Thus, the number of valid observations for analysis was forty-four.

3.3.2 PROBLEMS PRESENTED BY COGNITIVE CATEGORY ANALYSIS

Inspection of the data from the simultaneous coding sessions revealed the weaknesses inherent in attempts to apply the cognitive-pattern categories to empirical classroom observations. Although the personal-interaction coding (the column variables on the scoring sheet) showed a high degree of inter-rater consistency, the cognitive-pattern analysis (the row variables) was much less reliable. Statistical tests revealed few significant differences between the two observers at an aggregate level on *either* type of coding; however, the extent of agreement on the cognitive coding was less than that on the classroom-interaction coding, and could be seen to vary considerably from class to class.

We believe this was the result, first of all, of the difficulty for outside observers of characterizing the essentially internal processes of thought going on in many settings. Equally to blame, however, was the wide range of interaction frequently present in classes where small-group activities were taking place. We often found it impossible to characterize these multiple activities in any single category, even for small time units. The result was that the locus of the observer's attention during each coding segment became the main determinant of how that segment would be classified.

Probably due in part to these coding problems, a preliminary analysis of variance showed no significant contrasts among teachers, or subject areas, on the cognitive-pattern coding. We also explored differences by classroom type (as indicated in the upper left corner of the coding sheet). Classrooms were divided into: 1) "regular classrooms"—those without computer use; 2) "computer classrooms", which featured an entire period of computer use in a cluster-equipped classroom (applicable mostly at Tecumseh); 3) mixed regular and computer classes, in which computers were used for part of the period; and 4) sessions in the computer laboratory (applicable only at Brock). No significant difference among these types of classroom on any of the cognitive variables was located.

We continue to believe that the UNCAL cognitive categories have some theoretical validity, and participating Principal Investigators have found these categories useful to their qualitative analyses. A serious and sustained effort to evaluate classroom activity using the cognitive categories defined for RIACPTS might be fruitful, but only through a lengthy period of training, practice, consultation, and iterative analysis. Even after taking the problems of coding reliability into account, however, it must be noted that the overall proportions of cognitive activity only rarely included any entries in the categories of "global comprehension/understanding" or "construction/synthesis". Approximately 80% of all observed classroom activity was classified in the two lowest levels of cognitive functioning. This is generally consistent with other research findings which indicate that high-school instructional patterns rarely allow for independent, creative work by students (see Cuban, 1984; Tye, 1985; and section 3.1.1.1 below). The fact that so little variability exists in the dependent variables of interest eliminates the possibility of locating significant differences among groups of participants.

Even so, analysis of the observation sessions did yield a number of interesting contrasts on the patterns of *classroom interaction*, as defined by the Flanders scales, among teachers, students, and their computers. The remainder of this section will be devoted to discussing these contrasts, which generally reinforce the importance of the concept of subject subcultures to an understanding of the dynamics of implementing computers in the classroom.

3.3.3 CLASSROOM INTERACTION ANALYSIS AND SUBJECT SUBCULTURES

In our earlier descriptions of subject subcultures, we have stated that they find expression through a variety of different expectations and practices, but most notably through different styles of teaching and classroom organization.

> Thus, art students may be expected to have a different set of priorities, a different set of classroom activities, and a different way of relating to both their class work and their teacher than students in a history class. At the same time, the latter group of students would expect their history class to differ only slightly from their geography class. (Goodson, Mangan, and Rhea, 1990a, p. 31).

The nature of these subcultures is described in more detail in section 3.1.1.2 below. The application of this notion to our data implies a hypothesis about the character of classroom interaction: that, in general, art classrooms will be characterized by students involved in individual, creative work, with the teacher in a coaching and consulting role; whereas social studies classrooms will centre around more formal lectures and recitations, while featuring a more teacher-centred pedagogy. We would expect family-studies and technological-studies classes to fall somewhere in between, reflecting their combination of fact-based and practical content.

Our ethnographic observations to date have generally confirmed this hypothesis. Similarly, in our personal interviews the teachers have reinforced the validity of this concept to an understanding of their own approaches to curriculum and instruction. In the RIACPTS analysis, we found several variables to be of interest to an evaluation of this hypothesis: the proportion of time spent in teacher-initiated activity; the proportions spent in "recitations", i.e., question-and-answer activities (see Hoetker & Ahlbrand, 1969); and the proportions of large-group vs. small-group activity. Selected summary statistics from analyses of variance on these variables are presented and discussed below.

3.3.3.1 Teacher-Initiated Activities

Table 3.1 presents statistics for teacher-initiated activity, by teacher, subject, and "discipline", defined by collapsing subjects as shown into art, family/tech. studies, and social studies.

Table 3.1:
Mean Proportion of Instructional Time Devoted to Teacher-Initiated Activity

Teacher Code	School	Subject	Mean Proportion of Period in Teacher-Initiated Activity		
			Teacher	Subject	Discipline
1	Brock	Art	.0924	.1526	.1526
8	Tecumseh		.2329		
4	Brock	Fam.Stud.	.1010	.1639	.2494
7	Tecumseh		.2582		
5	Brock	Tech.Stud.	.2981	.2922	
9	Tecumseh		.2883		
2	Brock	History	.3995	.3804	.3345
10	Tecumseh		.3564		
3	Brock	Geography	.2306	.3028	
6	Brock		.4581		
11	Tecumseh		.2818		
		Overall	.2766		
		F Ratio	.9140	1.5254	2.1075
		Sig. F	.5322	.2137	.1345

There was no statistically significant difference among teachers on the proportion of teacher-initiated activity, though there is clearly a good deal of variance among them. It was interesting to note the extreme cases: the art teacher at Brock was observed to initiate specific activities in less than 10% of her class time, while one of the geography teachers at the same school devoted over 45% of his class time to such activities.

3.3.3.2 <u>Recitative Activities</u>

Table 3.2 presents the mean proportion of time devoted to recitative activities: teacher questioning and student responses.

Table 3.2: Mean Proportion of Instructional Time Devoted to Teacher-Questioning and Pupil-Response Activity

Teacher Code	School	Subject	Mean Proportion of Period in Teacher Questioning			Mean Proportion of Period in Student Responses		
			Teacher	Subject	Disc.	Teacher	Subject	Disc.
1	Brock	Art	.0111	.0198	.0198	.0194	.0288	.0288
8	Tecumseh		.0315			.0414		
4	Brock	Fam.Stud.	.0064	.0591	.0506	.0000	.0369	.0408
7	Tecumseh		.1381			.0923		
5	Brock	Tech.Stud.	.0643	.0463		.0444	.0428	
9	Tecumseh		.0342			.0417		
2	Brock	History	.0473	.1015	.1061	.0598	.1079	.0917
10	Tecumseh		.1692			.1679		
3	Brock	Geography	.0561	.1092		.0574	.0805	
6	Brock		.1230			.0641		
11	Tecumseh		.1542			.1133		
		Overall	.0734			.0643		
		F Ratio	3.0349	2.2435	4.6211	2.2560	2.1838	3.9934
		Sig. F	.0078	.0819	.0155	.0387	.0887	.0260

This table shows that the proportion of time devoted by teachers to *questioning* their students was generally low. However, three of the social studies teachers were observed to spend 12 to 17% of their class time in this activity, while the art teachers devoted 3% or less to it. This contrast was statistically significant (at the .05 level) for teachers, and retained its significance when they were grouped into disciplines. Not surprisingly, teacher questioning and pupil responses form a mirror-image pattern, so that the two activities generally vary together. Thus, pupil responses took the greatest proportion of time in social studies classes and the least in art

classes, with technological studies falling in between. This variable also showed a statistically significant contrast among teachers and among disciplines. Taken together, question and response activities accounted for a mean proportion of almost 20% of social studies class time, but less than 5% of art classes.

3.3.3.3 <u>Small-Group Teaching Activities</u>

The amount of time devoted to large-group versus small-group or individual instruction was coded separately as a dichotomy. Analysis of this variable indicates once again a statistically significant difference among teachers, and among subjects, in the predicted direction, as shown in Table 3.3.

Table 3.3: Mean Proportion of Instructional Time Devoted to Small-Group Teaching Activity

<table>
<tr><th rowspan="2">Teacher Code</th><th rowspan="2">School</th><th rowspan="2">Subject</th><th colspan="3">Mean Proportion of Period in Small-Group Teaching</th></tr>
<tr><th>Teacher</th><th>Subject</th><th>Discipline</th></tr>
<tr><td>1</td><td>Brock</td><td rowspan="2">Art</td><td>.9111</td><td rowspan="2">.9041</td><td rowspan="2">.9041</td></tr>
<tr><td>8</td><td>Tecumseh</td><td>.8947</td></tr>
<tr><td>4</td><td>Brock</td><td rowspan="2">Fam.Stud.</td><td>.8349</td><td rowspan="2">.7585</td><td rowspan="4">.7849</td></tr>
<tr><td>7</td><td>Tecumseh</td><td>.6439</td></tr>
<tr><td>5</td><td>Brock</td><td rowspan="2">Tech.Stud.</td><td>.8001</td><td rowspan="2">.7982</td></tr>
<tr><td>9</td><td>Tecumseh</td><td>.7969</td></tr>
<tr><td>2</td><td>Brock</td><td rowspan="2">History</td><td>.4365</td><td rowspan="2">.3584</td><td rowspan="5">.4643</td></tr>
<tr><td>10</td><td>Tecumseh</td><td>.2608</td></tr>
<tr><td>3</td><td>Brock</td><td rowspan="3">Geography</td><td>.7858</td><td rowspan="3">.5376</td></tr>
<tr><td>6</td><td>Brock</td><td>.3526</td></tr>
<tr><td>11</td><td>Tecumseh</td><td>.4004</td></tr>
<tr><td colspan="3">Overall</td><td colspan="3">.6436</td></tr>
<tr><td colspan="3">F Ratio</td><td>2.5504</td><td>4.5384</td><td>8.1265</td></tr>
<tr><td colspan="3">Sig. F</td><td>.0210</td><td>.0042</td><td>.0011</td></tr>
</table>

The same art teacher who spent the least amount of time in teacher-initiated activity, for instance, spent the most on small-group/individual instruction. A clear pattern emerged across subjects, with art classes devoting an average of 90% of instructional time to small-group activities, while social studies classes were engaged in such activities for less than half the time, on average (but with a noticeable range of differences among teachers).

3.3.3.4 The Influence of Computerized Classrooms

Given that these patterns of subject-based activity generally confirm our notions of subject subcultures, the relevant question for this project becomes: how does the introduction of computers into these classrooms affect the observed patterns? The answer, in brief, is that it has a profound effect, as revealed by Table 3.4.

Table 3.4: Mean Proportion of Instructional Time Devoted to Various Activities, by Classroom Type

Classroom Type	Teacher-Initiated	Teacher Questioning	Pupil Response	Small Group
Regular Classroom	.3667	.0949	.0787	.5076
Regular & Computer Class	.1527	.1083	.1260	.7538
Computer Classroom	.1895	.0326	.0216	.7887
Computer Laboratory	.1197	.0185	.0192	.9068
Overall	**.2766**	**.0734**	**.0643**	**.6436**
F Ratio	4.6272	3.0795	4.0647	4.2327
Significance of F	.0072	.0382	.0130	.0109

When treated in aggregate (without regard to subjects), regular classrooms were observed to devote an average of about 50% of their instructional time to small-group activities. Computer laboratory sessions, by contrast, saw an average of over 90% small-group activity. The computer lab, then, seems almost to impose a more individualized approach to teaching. This is probably because the software is designed to be operated by an individual or a small group, and students are free to work at their own, or their group's, pace. Field notes indicate that the large-group activity which did take place in the computer lab was almost entirely restricted to introductory instruction on the mechanics of running the programs.

As might be expected, where computers were located in classrooms and used as part of the lesson, the proportion of time devoted to small-group teaching fell between that of the computer lab and that of a non-computer class. The contrast among the types of classroom was significant at the .01 level.

3.3.3.5 <u>Interaction Effects, or the Lack Thereof</u>

The fact that significant effects were attributable both to the classroom arrangement and the subject area raises the final question as to whether these effects are independent of each other, or whether they are related or interact with each other. This was explored via a two-way analysis of variance, with discipline (grouped subjects) and class type as simultaneous independent variables. The results of these analyses are summarized below in Table 3.5.

Table 3.5: Results from 2-Way Analyses of Variance

Independent Variable		Type of Activity			
		Teacher-Initiated	Teacher Questioning	Student Response	Small Group
Subject Group	F Ratio	2.276	6.795	7.417	14.991
	Sig.	.100 *	.003 **	.002 **	.000 **
Classroom Type	F Ratio	4.620	4.601	6.436	8.654
	Sig.	.009 **	.009 **	.002 **	.000 **
2-Way Interaction	F Ratio	.545	.292	.292	1.516
	Sig.	.770	.936	.936	.205

* Significant at the .10 level ** Significant at the .05 level

In this analysis, significant effects for both subject group and classroom type were located on all four of the kinds of classroom activity discussed above—teacher-initiated, teacher questioning, pupil response, and level of small-group interaction. However, *none* of these relationships showed any significant interaction effect. The two variables act entirely independently of one another.

What this implies is that, as we had suspected from earlier classroom observations, the forms of interaction favoured by the introduction of computers into secondary schools cut across the established pedagogical patterns of existing subject subcultures. Those patterns are clearly reflected in the differences between disciplines in conducting classroom activities. The introduction of computers creates completely separate patterns based on the type of installation.

The implications of this finding may be quite favourable, as they indicate that the technology pushes teaching styles toward a more individualized model. But they may also bode ill for the adoption of computers as a normal part of the teaching practice of secondary school teachers in some disciplines. To the extent that teachers identify strongly with the teaching styles associated with their traditional subject subcultures, they may be reluctant to adopt a technology which seems incompatible with those subcultures.

We are thus led from the detailed examination of classroom activity back to more global issue of the potential clash between the culture of computing and the traditions of high school teaching—the same issue which opened our discussions in this volume. This potential culture clash has arisen again and again as a central theme in our research. It remains perhaps the central problem to be resolved if computers are to become truly productive tools for learning in high school classrooms.

3.4 GENDER EFFECTS IN THE INTEGRATION OF EDUCATIONAL COMPUTING ACROSS THE CURRICULUM

3.4.1 INTRODUCTION

A great deal of literature has been written on problems involving gender issues and education. With the advance of technology in all areas of the curriculum, it is now fitting to extend this research into the more specific area of educational computing across the curriculum. When educational opportunities are not equally available to all, regardless of race, sex, or social status, it is quite natural to judge that as unfair and to demand remedies. Such an issue has arisen over the use of school computers. PEER, the Project on Equal Education Rights, has reminded us that "simply having computers in the school building does not guarantee equal access for girls" (Becker & Sterling, 1987, p. 289).

The change process of implementing computer technology within a school system is complex, requiring three kinds of educational change: changes in people, changes in program or processes, and changes in institutions or organizations. Educational change is especially difficult with innovations regarding computers in the schools. Problems include a lack of trained teachers who acquired knowledge of computers during teacher training, scarce resources which prevent having enough equipment and supplies for full utilization, and few "model" programs to guide educational planners. Also, societal pressure to train children in technology is so strong that the change process is going forward in all three change areas at once: people, program, and institution (Smith, 1987).

In the past, much has been written about gender issues and education. In several Canadian studies, this research has now been extended into the more specific area of educational computing (Sullivan et al., 1986; Carmichael et al., 1985; Brooks, et al., 1987; Collis, 1987; and Moore, 1986). There are many possible theories for the observed differences in computing. Two of the more common ones are: it could be a biological difference in ability; or, it could be the effects of socialization, where students are reacting to lingering social expectations for females not to be involved in the use of computers and males to excel at such tasks.

Regardless of which theory one subscribes to, there are observable differences even within the scope of our project and many of the students are aware of them. Although we have not yet been able to fully define these differences, numerous classroom observations and interviews have raised many issues that should be considered in regard to gender differences and computing.

These issues will be dealt with in the following areas of study emerging from the data, including the effects of the following: physical setup of computers; type of classroom activities assigned and chosen; voluntary library computer use; keyboarding experience; prior computer use and background; peer interaction; strategies for use; teachers as role models; real and perceived societal pressures; and teachers' roles in promotion of educational computing by all students. Comments from both student and teacher interviews are included in the development of each of these issues.

3.4.2 OBSERVATIONS

3.4.2.1 Prior Computer Use and Background

Students have repeatedly commented that a background with computers puts some peers ahead of others when it comes to using computers at school, and that males seem to have more of this

background with computers than females.The effects of socialization are also visible in the personal lives of many of the students who refer to ownership of computers by their fathers or brothers, but rarely by mothers or sisters. This can be seen as part of a typical patriarchal pattern. Computers are frequently seen by males and females alike as being a part of the male domain, with male family members (regardless of age) having access to and knowledge of the machines. Perhaps it is a result of succumbing to familial and societal pressure, but even within the scope of this project, this has been seen to be promoted by **both** parties at times. This can be seen in this excerpt from an interview with a female student, who discussed her computer background and reluctance, as follows:

Student #1: I didn't do much with that computer [at home]. Back then was when I was terrified to use one. I didn't understand them.

Interviewer: Who did use them at home?

Student #1: My brother.

Interviewer: Yeah? Is he older or younger?

Student #1: Younger.

Interviewer: But he's pretty keen on it? What sorts of things did he do?

Student #1: He played games. I did once in a while, but not very often. He also used the printer, so he did a lot of his school work.

Interviewer: He wasn't that keen on teaching you how to use it?

Student #1: I wasn't that keen on learning how to use it.

Another female student felt very strongly that there was a male bias to computer use, and her frustration with this, at school and even within her own family, can be heard in her interview:

Student #2: The guys are always good at it, and better at it...because, well some of them, of course, have a computer at home and...I don't know why. I always find that males are better on the computer.

Interviewer: Do you find that they use it more, as well?

Student #2: Use it more as well, yes...They have interest in it. 'Cause, I don't know, before you would hardly ever hear of any girl using one and saying, "My Mom bought me a computer". No, it's always the guys saying, "My **Dad** bought me a computer"...And the girls would usually say, "My brother has a computer at home". That's usually what happens.

Interviewer: Do you have any idea why this might be?

Student #2: I don't know. Maybe...in my opinion, maybe guys are smarter in a sense of understanding these mechanical things, like it's considered mechanical. They are...it's a sign of power and...maybe sort of masculine. My sister uses it, she's a teacher, and she is doing programming but my brother-in-law bought it because he is using it for his work. And so you see, it's always the men who...My sister wouldn't get it. I say, "Well, you need it too, right?" She goes, "I need it, but...I won't get it. Like I don't know why, I wouldn't go and get it." But her husband will, right? I don't understand why.

Throughout most of the interviews, an extensive computer background was mentioned by most of the students as a positive thing, and most mentioned that males were more often the

beneficiaries of this. This background often led to computer usage, which was then interpreted by the females as greater ability.

These differences in attitudes to educational computing and experience with computers in the home were also supported by the questionnaire data (see Volume 1, Appendix 1.2). This questionnaire was administered to students involved in the project during three of the terms of observation. These were the students who had returned a signed consent form, according to the ethical review procedures. (For samples of the participant consent forms, see Volume 1, Appendices 1.3 to 1.5). When asked what their attitudes were to educational computing, of the 455 who answered this question, most students (73%) responded positively. In addition to this, 23% stated they were unsure, and the remaining 4% had a negative attitude to computing. Breaking these responses down further according to gender, of the 73% that were positive, 49% were female, 51% male; of the 23% that were unsure, 64% were female, 36% were male; and of the 4% that were negative, 67% were female, 33% were male. It must also be noted that of the total 455 students responding to this question, 54% were female. So, if all were equal, we would expect to see the percentages at 54% in each case.

One of the other questions on the questionnaire dealt with the presence of computers in the home. In this case, 42% of the 454 students responding to this question stated that they had access to a computer at home. Of those who said they had a computer at home, there was a fairly even distribution with 49% of the females responding positively. Again, however, 54% of the total sample responding to this question was female. This will be discussed further in the final sections of this report.

3.4.2.2 <u>Type of Classroom Activities</u>

As most of the computer activities were prescribed by the teachers, there was little opportunity to observe gendered choice of types of activities. What can be noted here, though, is that females seemed more at ease with and were more eager to participate in word processing activities (see also the following section on keyboarding). It was also noted that, in some cases, males and females tackled the same assignments in different manners while using the computer. The following excerpt from a field note regarding students using *Spectricon* for an Art class, demonstrates this difference:

> Male seemed much more at ease and confident than the female did. He chose geometric drawings which suited the medium, female chose human figures. The female requested assistance four times from male, two times from me. Both, however, worked very intently, and past the end of the period.

Other students noted differences between the use of computers by males and females. One student stated that male students were "more into werewolves and things like that and the girls are into pretty things. Like one of the girls I know has made a drawing of mascara and nail polish. She did a pretty good job too, but..."

In the analysis of computer use, the type of classroom activities selected by students is an area that requires some consideration. While using computers for different tasks is not wrong, the guidelines stipulate that **all** students should be taught how to use the computers most effectively. Care must be taken to ensure that this is being done. This includes learning to distinguish between computers and other media as best suited for different tasks. Students must make informed

decisions as to when the computer is an appropriate medium for the task at hand and when more traditional means would be more advantageous.

3.4.2.3 Voluntary Library Computer Use

At Tecumseh, students are allowed free use of the three computers located in the library. As this use is purely voluntary, it offers an opportunity to monitor male/female use of computers when not dealing with mandatory classroom computer assignments. Students using the computers were requested to sign a log-in book located next to the machines each time they used the system in the library.

Analyses of these data show a much higher voluntary usage rate among males than females. Of the 135 student entries into the log book, 84% were by male students, and only 16% by females. This supports the comments made by students during interviews that there were always groups of males gathered around the computers during free time. While not required to record the nature of their computing activities in the log, observations and interviews with these students indicate that the main use of the library computers was for creating images in *Spectricon*, and to a lesser extent using the simulation programs *Keep it Running-Car Rally* and *A Week in the Life of...*, and occasionally to prepare essays for other courses in one of the word-processing packages.

Interestingly, this trend holds true for staff as well. Of all the teacher entries in the log book, a full 90% were by male teachers. It should be noted, however, that most teachers would not need to use these computers for there are computers in their classrooms. There are times, however, when they are unable to access their classroom computers as other teachers are also booked into their classes during certain periods, so library computer use is also a consideration.

The following female student described how this male computer culture appeared in the library:

Interviewer: So you say that the computers here [in the library] are usually busy?
Student #3: Yes, usually.
Interviewer: Is it the same people that are using them most of the time?
Student #3: I believe so...I'm usually in the library at lunch quite a bit just because they are so long. I'd say so, and there's trouble, like people would come and talk and there would be a whole bunch...like it's mostly guys. Whole bunch of guys like in a corner just talking, so now it's computer users only.
Interviewer: Mmm. So that has become a sort of social centre there, has it?
Student #3: Yeah.

In terms of other voluntary experience, Chuck noted that males were generally keener to work longer on assignments, after class:

> But the ones who usually finish first and shut their computer off and are ready to leave the [computer] room fastest, are the girls in the class. Where I found that the students who stay longer and want to spend more time have been the males in the class...I think it's the guys who are more interested in it and the creativity of the process and the doing of the process itself and spending more time at it. Whereas the girls are, I'm not suggesting all, some of them, they sort of rush through the task, "Let's just sort of get it done, because we have to do it" type attitudes. And then they shut it off five or ten minutes early..."I'm ready to go now. Can we go early?" Whereas the guys are still...at

the end of the period several of them stay and want to do more. And several...I had lunch after this semester's class, sometimes I'm half-way through my lunch period with some of them still working away with what they were doing.

3.4.2.4 Keyboarding Experience

Perhaps it is a continuation of the traditional streaming of females into business subjects, but it seems to be quite common for females to have greater keyboarding experience than males. However, it does seem to be more acceptable for males to enrol in keyboarding (no longer called 'typing') classes than it once was. The results of this can be seen in classes observed during the past terms, as this field note suggests:

> In this class, **girls** often seemed to lead the way. No less than six instances of boys asking girls for help were observed. As this was an exercise with the *Editor*, I attribute this primarily to the fact that girls have some training in typing. Keyboard skills are essential to making any real progress with the word processors, and without those skills the use of other features tends to become more confusing and slower in developing. Girls who were able to type with speed and ease often came to understand and use other features more quickly, and thus became peer experts.

In an interview, one female student discussed the importance for females to have keyboarding experience, as it appears to be their only chance to excel at computer use, as males already have more interest and background with computers, and therefore do not require this skill as greatly:

Interviewer: Do you think there's generally any difference between the way guys react versus the girls?

Student #4: Yeah. The other girls in our class don't really like it too much, I don't—well, because they can't type. Typing is a big thing.

Interviewer: Can the guys type?

Student #4: No, but they like it better.

This difference is also noted by the males, as one who thought that although both genders were equally capable of computing stated:

> I think some of the guys thought it was sort of a little dumb to be working on the computers...because it has to do with typing, and women only type.

This sentiment was corroborated by another male who reported that:

> I don't think guys would want to work on computers as much as a girl would want to (laughs)...some people that I talk to, they hate computers, they think it makes them feel like a sissy or something.

Because of this superior keyboarding ability, this is an area where the females (at least at the secondary level) seem to "catch up" in their computer use with males. As a result, classes that do a great deal of word-processing assignments seem to have greater female participation than those that require experimentation with other software programs.

3.4.2.5 Peer Interaction

A great deal of, and perhaps even more, peer interaction has been noted in computer-use sessions, as compared to regular classroom sessions. When it comes to the actual use of the computers, however, as might be expected, males, who have the greatest computer background and confidence, are generally the "helpers" in most uses of computers, as this male student stated:

I find that some people who don't know anything about computers have problems with it. Like some of the girls, you know. I'm not picking on girls, but you know most of the girls ask me "what is this?" and "what is this" and "what is going on?" They're sort of blank on all of this.

The exception to this is found in word-processing assignments, where females, who are generally more experienced in these areas, act as tutors to males. Students are also very aware of their interaction with peers regarding computers. As one student, devaluing her own knowledge said,

There was one guy that was always in there with me...he had more experience than I did...and he helped me, and then I showed him the one thing that I knew, I found out by accident. So we just kind of went back and forth.

There were also observed cases of more definite "extensive tutoring", perhaps bordering on exploitation however. In one case, a male called a female student over to help him enter his notes in a word processing assignment. The female was a much better typist than he was. After working with her for a while, he got up and said, "Here Michelle, you do it." The observer was left with the question whether this was exploitation or peer tutoring? This could be an indication of how the experience of females, which should be an asset, is sometimes turned against them.

The students were aware of, and often confused by, differences when it came to computing, and peer interactions were affected by this, as can be seen in this interview with a female student:

Interviewer:	Did you notice any differences between the males and the females, or anything like that, that some were better than the others, or...?
Student #5:	Well, some of them always thought they knew more than us, but...
Interviewer:	But did they?
Student #5:	Not really. [laughs]
Interviewer:	No? Okay.
Student #5:	They were just having, like the same problems that we were.
Interviewer:	So, how did you get the impression that they thought they knew more? Did they say something, or act, or do something...?
Student #5:	Well, because they would try to help us and then it would be wrong. [laughs]
Interviewer:	They were offering their assistance but it wasn't really...? Did you notice anything like they were done quicker or anything like that?
Student #5:	No.
Interviewer:	Did they try to hog the machines or anything? Or did they just try to give you help when you didn't need it or want it?
Student #5:	Well, when our teacher said for six people to go back there [to the computers at the back of the classroom], it was usually guys.
Interviewer:	Oh, yes. So they were more eager to start, to get involved?
Student #5:	Oh, yeah.
Interviewer:	Do you have any idea why that is?
Student #5:	No.
Interviewer:	Do you think that while they were more eager and more anxious to go back there, you didn't think that they were any better?
Student #5:	They might...most likely. I don't know. [laughs]

3.4.2.6 <u>Strategies for Use</u>

There have been numerous citings of observation of males and females in regard to tackling new programs or encountering difficulties in using the computer programs. It appears that females are more apt to tackle such difficulties in an orderly, sequential manner, asking for assistance or consulting documentation if available. This is demonstrated in the following field note:

> Two girls are playing *Unusual Countries* together. Another boy is playing it by himself. Their teacher notes that the girls are going through clues in strict sequential order. However, as they gain experience their strategy seems to change.

Males, on the other hand, seem more prone to try a variety of keystrokes and move from screen to screen when unsure of what to do. Again, this could be a biological difference, or a result of socialization, where males are taught to be more aggressive and females to be more passive. This student's interview comment also demonstrates this phenomenon:

Interviewer: Did you notice any difference between the males and females and how they use computers?

Student #6: I think males are more aggressive.

Interviewer: And that would help them in using the computers or trying new things on them, or...?

Student #6: Yeah. It's actually an explorer and try different things 'cause that's the only way you're going to learn. A lot of girls just sat back and waited and talked and...

Interviewer: Waited for help?

Student #6: Yeah.

Along with this greater level of confidence leading the males to experiment more with the computer programs, the students also reported that the males "hacked" more, something that was never reported as an activity of the females. As one male student proudly claimed: "...I was with a couple of guys and we used to wreak havoc inside them [the computer systems]. We'd just screw them right up. It was hilarious." And, when asked if there were any other computer activities in which he participated in History class: "...We tried, Dave and I, to get into Mr. Nance's mark scheme but we couldn't. [When we got to a certain point, it said] 'You got no access to get in here.'"

The following teacher noted a difference in learning styles and strategies of his students:

Carl: Do you know the expression, 'high tech and high touch'?

Interviewer: Yes.

Carl: Yeah, well I have a feeling, I don't know whether it's correct or not, but I have a feeling that the girls prefer things that are high touch rather than high tech and they, to them the computer is kind of an alien experience. I might be wrong but, I just have this intuitive feeling about that.

Interviewer: Does that carry over from the classroom, their inhibitions? Or do you think in the classroom, because they can actually touch their hard copies and....

Carl: Yeah I think the latter.

Interviewer: Okay, so it's just then when it goes to the computer?

Carl: Yes.

3.4.2.7 Societal Pressures

The students seemed to have clear pictures of what was and what was not socially acceptable in terms of computer use. For instance, there were numerous instances of females complaining about not wanting to use computers. They did so loudly, complaining about their back, their eyes, the content etc. However, if the males were not interested they were rarely observed to state this publicly. This has not gone unnoticed by the students, who frequently mentioned this in interviews.

Other than these complaints, the students recognize the fact that females are not expected to be able to use the computers, and many then choose to go along with the expectations of them and "play dumb". The following female student, touched on this while discussing females' use of computers:

> When you first come on [the computers] everything is new...In the lab there, they're screaming "Gosh, how do I get in?" and "How do I get out?" and "What do I do here?", and **I think that it's sort of expected for us to not**—You know what I mean? Like, I mean, I'm not saying that it's, that we do it purposely, but some of them get on and go, "Oh well, somebody's gonna help me, so I'll just, just fool around or won't try anything for myself."

There are indications that these traditional stereotypes may change, as was discussed in terms of enrolments in certain subject areas that have currently been held by members of one sex:

Interviewer: My impression has been that in some ways there's been more girls moving into traditionally male courses than there have been boys moving into traditionally female courses.

Betty: Girls are much more eager to jump that stereotype than boys. It's going to take boys longer to feel comfortable in traditionally female courses. I think you'll find that everywhere. But in time I think it will come.

That time has not come yet, however, and males are still dominating the use of computers in the schools. Students have mentioned that it is common for groups of males to use computers, but never females:

Student #7: I notice that there are more guys using computers than girls.

Interviewer: And do you think that is a general thing, that generally guys will use it more than girls?

Student #7: I really don't know if it is, but like I said, that group hangs out together.

Computers are still considered to be a part of male empire, like machines that are also considered to be "male turf". A student who finds that computers are still considered to be a part of the male domain, and rightly so, said:

> Guys are smarter in a sense of understanding these mechanical things, like it's considered mechanical. They are...it's a sign of power, and I don't know, maybe sort of masculine.

In addition to these problems, girls are still taught to believe that they are not as capable when it comes to computer use, based on a number of factors, including their limited experience, math skills, and lack of confidence:

Interviewer: Does it intimidate you at all that the guys seem to be dominating the machines? Or would that stop you?

Student #8: Oh, no! Oh, no. It's just that I'm not very good with computers.

Interviewer:	Are they?
Student #8:	They seem to be.
Interviewer:	And do you think they have more background, or pick it up easier, or...?
Student #8:	They probably have a little more background than I do. They might pick it up easier, I'm not sure. I'm very poor in Math and stuff. I don't know if that has anything to do with it. I'm told it does. I don't know very much about computers.

This sense o: power and prestige is played up by the males, who brag about their "accomplishments" with the systems. As mentioned previously, "hacking" was an activity that carried prestige among the males. Hacking was not only a socially acceptable way for males to use computers, but was impressive as well to females, who stated that they would never consider participating in such activities. Word processing is more appealing to this female student who states:

Student #9:	I think guys—like since my last computer class, when I took computers in grade ten—it seemed that the guys were more into it, like I remember at lunch hour, I'd walk by once in a while and I'd see like a load of guys in there, but there really wasn't that many girls in there. Like at lunch hour, like hard core guys who got the video games and all that kind of stuff.
Interviewer:	The hackers.
Student #9:	Yeah, the hackers.
Interviewer:	But you were never a hacker yourself?
Student #9:	No, no.
Interviewer:	Have you ever spent your lunch hours using computers?
Student #9:	A few times. For projects and stuff, sometimes I would go in there and use the word processor, but it was really rare that I would.

3.4.2.8 Teachers as Role Models

Teachers are a source of role models for students, and hopefully they will be positive models rather than negative ones. Unfortunately, however, this is not always the case. Often unintentionally, teachers send the wrong message out to students. As expected, over the course of the project, not only did we see teachers demonstrating positive examples in the classroom and the lab, but negative ones as well.

Teachers need to do more than just talk about equality, they need to demonstrate this as well. Students are often given mixed messages by their teachers. Schools are filled with examples of sexism. While observing classes, an announcement was sent out by the office, requesting "ten males to come to the office" to help unload boxes from a truck. Although there were several protests about this clearly sexist demand from female students in the class being observed at the time, the teacher ignored these and complied by selecting only males to be sent for the task.

One student expressed concern that in her experience not only did she find that males dominated the computer classes and the computer use in the classes, but that computer teachers were never female either. In her experience, they were always male, and if there was ever a female computer teacher, she was sure that no one would take this person seriously and that she

would be given a very hard time. Her comments highlight the importance of getting more female role models involved in educational computing.

Positive role models exist in the schools as well. After discussing the male dominance of computer use time, the following dialogue took place:

Interviewer: Do you think having a female teacher would help at all in...

Student #10: Help?

Interviewer: ...dispelling that male dominance thing?

Student #10: Yeah, I think so. Barb seemed to let us do our own thing, though, 'cause, of course, we're older, like most of us are 20, 21, so she left us and most of the time we did work out our own problems on it. But, I don't know if she was in there, well obviously it would be different...but she always encouraged us to go on it. I think she's a really good computer teacher because she's really patient with you...and if you don't get it right the first time, she'll come back and she'd do it over and over again, you know.

3.4.2.9 Teachers' Reactions to Gender Issues

Surprisingly, in spite of the differing reactions of the students, all of the female teachers noted that there were no gender differences in ability or usage of computers. The male teachers were more aware of a problem, noting things like differential levels of computer use in free time. This could be seen as over-protectiveness on the part of the female teachers, confusing ability with actual usage, and not wanting to reflect negatively on the females. The inequities in computer use must be addressed, not ignored as some teachers chose to, who felt very strongly that there were no differences between male and female students when it came to computer use.

Another female teacher stated that there would not be much difference in computer use, as you use your hands with computers, and it is not necessary to use muscles or strength. Therefore, she felt that there was no difference. She equated the fact that there is no basis for inequities with the absence of inequities. When questioned further she did recognize that males are generally more vocal about their accomplishments, and thought more highly of themselves.

When asked, the male teachers, on the other hand, all noticed gender differences in educational computing. One male teacher recognized the differential social pressures and traditional-role stereotyping, first with females:

Carl: When I said to the class, "I'd like you to type your notes for this lesson", the girls would have no fear at all. What I think probably that most of them have probably taken keyboarding.

Interviewer: Are we getting then back to the females, secretarial, stereotyping there?

Carl: I think there might be a bit of that, you know.

And later, in regard to his male students:

> But what I would predict is that when we start using *CADTutor* in a big way, that the boys will take to it very well, because they regard that, for the same reason, as being a kind of a male bastion.

Recognizing this problem, he is concerned and is trying to do something about it:

> The way I look at it as a teacher and as someone who has worked a long time in industry, is that 50% of the workforce, 50% of human beings within Canada are female, give or

take a few percent. And we're approaching 50% of the workforce being female. It would seem that my duty as a teacher is to ensure that, even if people are reluctant, they still should be exposed to it, you know. You know I really encourage that. One of the objectives of this department in the coming year is to increase the female ratio within the technical department.

Another male teacher noted the differential voluntary use of computers by males before school:

Interviewer: Do you see any difference in their performance when it comes to using computers?

Harry: No. It's funny, because some of the programs, like when I go into the class in the first...like if they get in there ten minutes early or five minutes early, some of the guys rush in and they go back and they turn the computers on and they work on the *Draw* program, or not usually *Draw*, but *Spectricon*. And so they play around with that and they tend to be a little more apt to go back and try new things then do different things than the girls do. Like I don't have any girls that rush in and do that. They are in the washroom combing their hair. That's just what I see. And I don't think it matters whether they have confidence in using the computer or not. It think it is just priorities at this point in their life. A computer isn't a big priority with a lot of the girls...although girls do just as well as the boys...I don't think there is a difference there. Just the priorities and the nature of the beast at this time in their life.

The following teacher noticed a difference in the level of confidence and inhibitions held by the students:

Carl: Most classes seem to be broken down into two groups, one group have no inhibitions as far as the computer. The other are total, to them it's a totally alien thing and it's very difficult to break through that and convince the kids that this is a genuine tool that you should, you should use and I don't know whether they didn't experience it in elementary school, or...

Interviewer: Well that's what we're wondering is if they're the ones with inhibitions. Do you have any idea of their backgrounds or anything?

Carl: Well it was mostly girls that had the inhibitions.

3.4.2.10 Physical Setup

The physical setup of the computers seems to have a large effect on differing gender reactions to computers. It appears this is an area where there is ample opportunity to easily decrease the gender differences in computing, as our observations show that when all students have controlled, but equal access to computers, eliminating the competition aspect, the gender differences are minimized. This can be achieved in two ways: a computer lab (as at Brock) where every student has equal access to a computer; or in a classroom cluster situation (as at Tecumseh) where there is the possibility of the employment of a strict computer use schedule, where students regularly rotate through opportunities for computer use. As one teacher stated, "I think everybody is capable of using the machinery, and everybody can get something out of it." Another example of

the effects which can be seen given equal opportunity to use the machine can be heard in this student's interview:

Interviewer: What about for how much they [males and females] used the programs, and used the computers? Did you notice any difference there?
Student #11: No, Ms. Farnham had us use it according to the schedule, so...
Interviewer: So everyone used it equally?
Student #11: Yes.

If, however, there is not guaranteed equal access to the computers, the gender differences are accentuated. This can be seen more where there are small clusters of computers for a large number of students. This phenomenon can be seen in the following example:

Interviewer: Has your teacher actually given you any assignments where you were required to use them [the computers]?
Student #12: No.
Interviewer: So, it's been strictly voluntary.
Student #12: Yeah, if you want to use them, you have to ask.
Interviewer: Do you sense that there's any sort of competition to get on the machines?
Student #12: First arrived, first served.
Interviewer: Yeah? And are there certain people who usually get there first?
Student #12: Yeah.
Interviewer: Yean? So has there...I mean, let's say you wanted to use the system and somebody else is on there. I mean, do you just wait, or do you ask them, do you let them finish, or...?
Student #12: You have to wait. Wait until they're done. But mostly, you're gonna have to wait until the next day because they're gonna be on there for a whole period.
Interviewer: Have you noticed any differences between the guys and the girls? Do guys seem to use them more or do they...?
Student #12: Yeah. Guys use them more.
Interviewer: Do you think that's because they're more interested in them or just because they get there first, or do you think the girls feel like they're getting pushed out of the way?
Student #12: No, girls don't, they don't go.

There are problems involved with rotation schedules for computer use as well. Many things can interrupt carefully-made classroom schedules, causing even well-intentioned teachers to cast them aside, and get on with survival in the classroom. As this teacher said:

Interviewer: The scheduling, did it work out? I think at the beginning it was working out but as you were getting into assignments it couldn't be followed as...?
Wendy: There's too many interruptions. Just as far as the year goes, there's school interruptions, and auditoriums, and...there's a lot of things going on that ruin a schedule, and kids are sick a lot.
Interviewer: Right. Fully realizing that it is not going to work out to the end, would you try a schedule again next time?

Wendy: Yeah, sure. I think it is a good idea. Gets everybody on there the first time anyway. So those who have natural reluctance to try computer work, they are scheduled in like everybody else that same month, and so in they go and they complain, "Oh no, I'll never get this". And then they find how easy it is. That the software is very user-friendly and they get to...and after that first time I figure if I get them once, then they are not scared the next time.

One theory for this difference has been noted by students who feel that males are generally more aggressive and that this aggressiveness follows through with the use of computers as well. It appears that whether the origin of this aggressiveness is biological or a result of socialization is irrelevant to these students, who are just concerned with equal access. As one female, uncomfortable with the term "feminist", stated:

> Girls, I found that they seem to shy away from it [the computer] because the males sort of dominated it, which kind of bugged me, but you know, I mean, I'm not a feminist...I don't know. I'm gonna blame it on the guys because they come in and [say] "Here I am, in the work force" and everything and "Oh, I need this" and they'd sit there for hours and hours...I think it really turns off some of the females in the class...You know, there's one particular girl who hasn't been on it for more than a half hour all year.

As these students state, there are in many instances examples of differences in the computer use of males and females, and this difference is magnified by the physical setup of the computer installation and the strategy employed by the participating teachers. A setup that necessitates competition on the part of the students in order to access the computers, especially a combination of classroom clustering of computers and a teacher strategy which does not require equal access to computers, has been seen to be favourable to male students and detrimental to female students.

If, as this evidence suggests, there are inequities involved in the use of computers in schools, this should be of major importance to all educators, as the negative impact of this may outweigh all of the possible positive effects of this new technology. Identification and alleviation of this should be given utmost priority in the implementation of computers in schools. This problem must be openly discussed among educators and students in order that all students may benefit from the introduction of this new technology. This will require a massive effort, including changes in physical setup of computers, teacher strategies, and, most importantly and problematically, changes in attitudes of society as a whole in regards to roles and expectations of males and females. It must be a critical consideration in the integration of computers into the curriculum. Following a review of literature relating to this issue, these data will be analyzed with respect to this literature and implications for educators will be discussed.

3.4.3 DISCUSSION

Generally, data gathered in this research project has backed up that of the literature. Those who have noted a gender difference in educational computing have in most cases attributed this to the corresponding socialization of males and females in terms of attitudes towards computing in term of what is socially acceptable. Students, ever conscious of fitting in with their peers, pick up on this and respond accordingly. Similar to findings in the literature reviewed (e.g. Collis, 1987; Sanders & Stone, 1986; Women's Action Alliance, 1987), innate differences in ability were not considered to be a factor in this issue by those in this research project. If males were seen to

be performing at a higher level it was attributed to greater interest and experience rather than greater natural ability. Differences in computer background, home computing, voluntary computer use, physical setup are all well-documented in the literature reviewed. In addition, the importance of teachers' attitudes is repeatedly discussed.

In terms of our statistics gathered through the administration of the student questionnaire (see Volume 1, Appendix 1.2) and those reviewed in the literature regarding gender differences in attitudes and home computing there are similarities there as well. While our students were generally positive about computer use, a much higher percentage of females than males responded in a "negative" or "unsure" fashion. These statistics regarding access to home computers backed those of Collis et al. (1989) and Becker and Sterling (1987). In addition, Collis et al. discussed how much these students actually **used** these computers and found gender differences there, with the males actually using their home computers more than the females.

This computer use at home has been shown by Levin and Gordon (1989) to be very important. They found that prior computer exposure (in particular, having a computer at home) has a stronger influence on attitudes than does their gender. Girls who own (and use) computers are closer to boys who own computers in their perceptions of the computer's functional abilities; regardless of sex, pupils who have computers are more inclined to view them as capable of performing cognitive/creative activities than are pupils who do not own computers. They are also more motivated to become familiar with computers, and feel a stronger need for computers in their lives than do those who don't own computers. Positive parental attitudes toward computers may be responsible for both the presence of computers in the home and the more positive attitudes of the pupils.

What is so concerning about these differences is that as more women are entering the workforce, by necessity and choice, in the near future 50-75% of the jobs will involve computers in some way. The importance of involving girls in computer education must be communicated to teachers, principals, school administrators, students and parents if girls are to have the best chance possible to increase their economic status.

Another interesting comparison is that of the effects of physical setup on computing. In this project, it was found that a computer lab offered hope for female students, as in the classrooms where there were only three computers available, they were generally quickly claimed by male students. While a computer use schedule would alleviate this problem, very few teachers actually used this method, as it was also problematic. School assemblies, sporting events, field trips and student illnesses seemed to repeatedly foil their attempts at ensuring equal usage in this manner. As a result, it generally resulted in a first-come, first-served approach to computer use. Generally, the males were first to gain access. As a result, we found that the computer lab offered the best hope for equal computer usage, since there was no competition for access to computers as each student could use their own machine. There are problems with this as well, as open labs, as well as library groupings of computers can become established as male territory, further intimidating female students.

This information combined can tell us that there is no "foolproof" method of ensuring equal computer usage between the genders. Regardless of the physical setup of equipment, gender of teachers involved, numbers of computers at home, keyboarding and peer interactions, equality is not guaranteed. **If handled improperly** they can still lead to unequal usage. Teachers need to develop strategies to increase the chances of having an equitable learning environment for their

students. The recommendations at the end of the report outline some of these strategies discussed throughout this report.

3.4.3.1 Summary

While there is definitely a problem with unequal usage of computers, most agree that there is no outright conspiracy here. As the Women's Action Alliance (1987, p. 2) states, "Nobody is hanging 'No girls allowed' signs on the computers." The computer-use gender gap is caused by a variety of socialization issues, beginning with the observation that it is predominantly males who use computers, which causes girls to decline computer opportunities available to them, which increases male-female computer-use ratio, which discourages more girls from approaching the computer, which...and so on.

Realizing this, the other part of our challenge is to make computing more attractive to females, restructuring educational computer use. Development and selection of software must be done in a manner that is more sensitive to females' interests and learning styles. The social pressures on adolescent females should be taken into consideration, and allowances should be made for paired-use of computers. This restructuring would also include monitoring for equal use as well as removing the "male image" of the computer rooms. This restructuring may help in the promotion of computer use for females.

If girls avoid the use of computers, that's bad news, because computers will increasingly be everyday tools in the jobs that women will want to have. As our economy becomes more computerized, people without computer skills will find themselves more and more handicapped in the job market. People who avoid computers because they saw it as taboo during childhood are likely to have a hard time overcoming their negative attitudes in order to learn computer skills as adults. And the way things are going now, a disproportionate number of these people will be women. Something must be done, and as Ragsdale (1988) states, the solution is much more complex than simply requiring that boys and girls spend equal amounts of time using the same computer applications. Our job now is to make it socially acceptable and to restructure educational computing to make it appealing for girls to take the opportunities for computer education that are available to them.

3.5 TIME REQUIREMENTS FOR COMPUTER IMPLEMENTATION

While one of the commonly-heard benefits of computing is to save time, as may be expected, the initial incorporation of computers into the education system actually demands a great *expenditure* of time. Time is required on a variety of levels and at different stages in the implementation of computing. The time requirements can be divided into the following:

1. Time is required to select and set up computer hardware and software.
2. Time is also required to train teachers to use the computer hardware, requiring both time on the part of the computer support person as well as the time of all of the teachers involved in the training.
3. Teachers need time for the exploration, familiarization, and ultimately selection of appropriate software programs for their curricula.
4. Once this is completed, teachers must either alter existing plans or design new ones in order to incorporate computers into their courses of study.
5. Once the teachers are fully confident with the computer systems, they must then undertake the instruction of all of their students to learn basic computing skills in order to complete classroom computer activities.
6. Additionally, time is required to maintain the computer systems and solve technical problems as they arise.
7. Time is required by consultants and teachers on an on-going basis to keep up-to-date with applicable educational software and hardware.

As a result of all these requirements, the teachers felt very strongly that they needed extra preparation time in order to cope with these demands. Each of these requirements will be discussed in greater detail in what follows.

3.5.1 INITIAL SETUP

In this case, the full-time Board Liaison was responsible for the purchase and set-up of the computer systems in the two schools and in the research office at the Faculty. Selection of hardware and software was a collaborative effort between the Board and the Faculty, and installation of the systems was done with the assistance of the Board's computer technicians. This entire process took several months of work on the Liaison's part, and must be considered in planning for the introduction of computers in an education system. Time must also be budgeted for delivery of equipment and frequent delays in shipping.

3.5.2 TEACHER TRAINING

The problem of time required for training was of great concern to the teachers in the project. While they recognized that they required the time out of the classroom to attend the training sessions, most were very hesitant to take that time, for they were concerned with missing four full days of classes and getting behind in their classroom activities. While a supply teacher was provided in each case to take over for them while they were attending the sessions, most teachers felt that it was not ideal for a variety of reasons: the work was generally not covered as they wished it to be; they had to prepare the work anyway; they had to go over it again when they got back; and they still had to mark any assignments from their missed day. As Harry commented,

"A supply teacher is fine, but teaching, that's the fun part. The hard parts, the preparation and marking, still have to be done."

It was suggested that perhaps the sessions could be held outside of class time so that teachers would not have to leave their classes, and that the money intended to pay supply teachers be used to compensate teachers for their time attending evening or Saturday training sessions. This suggestion was turned down by the Board as it was against their policy.

The training process required a great deal of time on the part of the Board Liaison as well. Initial training sessions for two groups of teachers, as well as on-going training with more subject-specific software packages required extensive familiarity with a large variety of programs, and the proportionate amount of time to obtain this level.

3.5.3 SOFTWARE EXPLORATION

Aside from the time required to familiarize themselves with the computer hardware, the teachers also required time to explore various software packages, and to select appropriate programs for their classes. Generic tool programs offered a variety of uses, but generally required a high level of familiarity on the part of the teacher in order to ensure confident and competent use in a classroom situation. Other subject-specific simulation programs needed to be examined by the teachers to determine the applicability to course content. Teachers often examined several software programs before finding one appropriate to their intended uses.

Teachers voiced a desire for greater preparation time to do such exploration of software, as the present contractual amount of preparation time was already consumed with a variety of other demands, including cafeteria supervision, meetings, and on-call classroom supervision, leaving no time for the additional use of computers. Diane requested to have:

> ...a block of time where I could say, just sit down and say, "Okay, today I want to work on developing a *Co-Co* program." Anything I do is incidental now, if I'm doing something in preparation—a test, a quiz, a worksheet—I may say, "Hey I can put that on the computer and print it out." But if it means sitting down and saying, "Okay, I'm deliberately going to try and do a *Co-Co* thing for my class," essentially I need more time than I have right now to effectively do it.

This extensive time commitment on the part of new users was described by Ed as:

> ... it's like stepping into quicksand. The more you get involved, the deeper in you get and it becomes more and more work. And you know it's going to be worthwhile, but it sure consumes your time.

A term after this comment, he reiterated his thoughts as follows:

> Within the first week, I described this as like stepping into quicksand. As soon as you start to learn, you start to realize the potential of the computers, it just sucks you in because you just realize that in order to develop that potential you just have to put hours and hours and hours of time into it. The result of that is going to be fantastic. I think the learning that will go on with the students will be far more diverse and with a great deal more potential to sort of open up horizons, to do things that we couldn't ever do before because you just didn't have the time to do them. Now the computers will cut down that time. Number crunching is a good example. But you have to have the time to develop those things.

3.5.4 PROGRAM CHANGES

Once the requisite knowledge of the software programs was obtained, the teachers either altered existing lesson plans to incorporate computer use or designed new lessons in order to do so. The former was the method that seemed to require the least effort on the part of the teacher, and the route most commonly followed by those involved in this project. There were teachers, however, who completely restructured their course outlines in order to use the computers in their classes. Most teachers, though, commented that this is something that they thought would be worthwhile to do in order to get the full benefits out of using the computers, but that it required a great deal of time, time they were unable to find to date. Earlier, teachers said they might make that a summer project, as they would have more time then. Elliot, a teacher at Tecumseh, where they have small clusters of computers in the classroom, said:

> But I think if I want to use the computers more, with three in the room, I've got to be more flexible in letting kids work at a different pace, work on different things at different times, so that the group using the computers, when I have kids on the computers, other kids can be doing something differently—maybe preparing for the computer, or maybe just working in another area totally. And for me that's going to require a fairly significant shift, 'cause I find it fairly easy to come in some days unprepared, then fall back on my experience, or fall back on the fact that I know a certain page in the textbook has some information that's necessary, and to have the kids read it. So it means sitting down and doing some fairly drastic revisions of the ways I've done things in the past, to tailor it more to individuals or to small groups. And again, that's something that I was thinking I'd be doing over the summer, to a certain extent, to try and make better use of these.

Diane, who had access to the computer laboratory, voiced similar concerns by saying:

> I had to spend more time on certain things than I would have spent. My lesson plans I had to spend more time getting ready too, just because I wanted to be very sure of what I was doing before I took the kids in to use the computers.

This major investment of time must also be considered in terms of payoff for the teachers. Earlier in the project, the teachers knew only that they were participating in a three-year research project, with no guarantees of what the Board would decide to do with the computer equipment at the end of the project. Many of the teachers were hesitant to invest the time required for a major change in curriculum to incorporate computers if the computers would be relocated following the completion of the project, making the changes valid for a maximum of a couple of years. As Harry stated:

> You've got to realize that I'm not going to spend hundreds of hours changing my courses, and then a year-and-a-half down the road, not having access and being out in left field some place. If we're sure that we're going to have at least three computers in each classroom, we can change our organization to take that into account. But I guess I'm not going to, like I said, spend hundreds of hours, potentially, changing everything that I'm doing, and then having them yanked out.

This concern on the part of the teachers was soothed, however, for at the end of the third term of observation, the Board announced that the computers would remain in the two high schools at the end of the research project. Many of the teachers commented that this was a great relief to

them in terms of the amount of time and effort they have put forth over the first year-and-a-half of the project.

3.5.5 COMPUTER CLASSROOM ORGANIZATION AND STUDENT TRAINING

In addition to the time requirements for altering lessons to accommodate the use of computers, there were additional classroom management tasks required with the use of computers in education. Teachers involved in this project found that they must also set aside time to log each of their students' names and passwords on to the network, create class lists, and to keep track of student computer-use time. This was in addition to the time required to train the students how to use the computer hardware itself, as well as the applicable software packages, if they were to be used for classroom activities. This entailed a considerable amount of time which also required scheduled on the part of the teacher.

This amount of training time was often greater at Tecumseh, with its classroom clusters of computers, where teachers would only be able to teach a small group of students at any time, requiring them to repeat their instruction several times. At Brock, where teachers had access to a computer lab and Robotel *Microselect*, the initial training seemed to be much quicker and less problematic.

3.5.6 ON-GOING MAINTENANCE

Time was also required to maintain the computer systems in the participant schools. Generally, this time could be provided either by the computer support personnel (located internally or externally) or by an in-school site administrator. If there is no computer support available from the school board, there is a great need for an in-school site administrator. This is typically a classroom teacher who has an interest in computing. During the life of this project, the teachers had access to the Board Liaison, who was filling the role of an external computer support person, in addition to a teacher from each school who was acting as a in-school site administrator. Ed, one of these site administrators, who was also a subject department head, said that he borrowed department administration time to fulfil this role. The other was a classroom teacher who was filling the requirements of a site administrator in addition to his regular classroom duties. Neither of them received any compensation from the Board in terms of classroom release time or special considerations to fulfil these tasks.

Regardless of the source of this computer support, or whether one was being compensated for his/her time, there is a definite need for this assistance. This need can be heard in Diane's comment:

> A teacher is really valuable ... and it's a waste of time if there isn't a person who you can turn to for technical advice ... it's a waste of time because you're just not going to use it [the computer].

As technical difficulties arose, they were usually accompanied by a loss of time, associated with the loss of work on the part of teachers or students. In addition to this, schedules were disrupted by computers being out of commission for repair time. Both of these losses must be taken into consideration, highlighting the need for immediate technical support to minimize the problems as they arise, thereby reducing "down-time".

3.5.7 ON-GOING TRAINING

As the experience with computers increased, the time requirements for computing decreased. Once the hardware and software were initially installed, many of the demands on time listed above decreased. At this point, support personnel were required much less for technical problems and routine maintenance, with teachers only requiring time to keep up with new software packages. While this training was not as intense as that of the initial period, it was a very important part of the effective use of technology in education. Teachers began to reap some of the time-saving benefits of computing as well. It should be noted, however, that while this demand on time decreased, it was not, and will never be, eliminated as there will always be new hardware and software programs to investigate and technical problems to solve.

3.6 TECHNICAL SUPPORT AND TRAINING

3.6.1 TRAINING AVAILABLE WITHIN PROJECT

In the first term of the project, each of the teachers in the project received four full days of in-service training, with back-up teachers receiving three days later in the term. Peder Nielsen, the initial Board Liaison for the project, conducted the well-received introductory computer training sessions for the teachers involved in the project. The unanimously positive reception of the sessions may have been due in part to the approach taken for the training. Prior to the scheduling of the sessions, meetings were held with all of the teachers to discuss the best method and timing for the training days, in relation to the teachers' busy teaching lives. After some discussion, a consensus was reached on the proper scheduling of the sessions. Having an input into the decision-making process seems to have had a positive effect on the attitudes of the teachers and on their willingness to co-operate with the training sessions.

These training days were held in the computer laboratory at Brock Secondary School one day a week for the respective number of consecutive weeks. The software introduced to the teachers was a variety of Ontario Educational Software Service (OESS) programs, other commercially-prepared Ambience programs, and MS-DOS packages (which ran under QDOS). This training mainly involved the use of "tool" programs, such as word processors [*Write, Storymate, WordPerfect*], a spreadsheet [*Democalc*], drawing programs [*Draw, Spectricon*] and *Imark*, a marks-management package. Other programs demonstrated and explored by the teachers at that time included: *Co-Co, Curriculum Crosswords, Build a Shore Bird, Art Treasures, Contributing Canadians*, and *Unusual Countries*.

In addition to this, individual teachers received further assistance with subject-specific software as requested by them from time to time. This instruction, given by Peder Nielsen during the first year and by Doug Little, who acted as Board Liaison in the following years, included the following programs: *IPaint, Show 'n Tell, Electronics Workbench, Electricity and Electronics, Logic Gates, Keep it Running, Construction Cost Estimates, Food Nutrient Tally, A Week in the Life of..., Decide, Your Excellency, Bartlett Saga—The Golden West, B.C. Lumbering, PC Globe, World Correlations*, and *Watfile*. During the second year, all of the teachers also had the opportunity to receive training on *WPro*, another word processor.

In addition to the training received with specific software programs, teachers at Brock also experienced the use of the Robotel Microselect, which enabled them to selectively broadcast contents of one computer screen to others in the computer laboratory. Teachers from both schools also received instruction in using the *Grolier Encyclopedia* on CD-ROM, connected to a stand-alone MS-DOS machine and a printer.

Aside from the listed training sessions, support was required regularly from the Board personnel for technical problems as they arose. Informal refresher training was required by some teachers after long breaks from school, and in routine classroom computer management. Entering student personal spaces and class lists on the system required further understanding of the system and this training was also provided by the Board Liaison.

These computer support personnel were also required to perform regular maintenance of the systems. Computer paper, ribbons, and ink cartridges required frequent replacement and attention in order to ensure smooth operation in a school setting. A steady supply of materials was a necessity, as teachers could not afford class disruptions caused by waiting for replacements. To

date, the Board Liaison has also filled this role in the two schools. Because the same person has handled both the roles of training and support, though technically separate, these roles have frequently become conflated in our discussions with teachers.

Technical problems also arise from time to time and require immediate attention. During the first term of observation, *Spectricon* in particular caused several system crashes. Due to the efforts of the Board Liaison, this improved in subsequent terms, as the developers of the program released an improved version of the program, with additional compatibility with the colour printers. Other printing problems and program crashes occurred occasionally, and support personnel were available to assist teachers at that time. As Diane commented,

> We have had horrible technical problems, but there has always been someone there to solve them. And that has made absolutely the total difference between frustration and not using it, and using it a lot. When there is someone there who you know will immediately come and help you or solve your problem, you are going to keep on using it, you're not going to get frustrated.

From all of the above, it is very apparent how critical it is to have proper computer support available to the teachers. This is something that every teacher has mentioned during interviews. Typical comments are as follows:

Elliot: Whenever I've asked him anything, he's taken the time to give me an answer...he's doing a good job of making himself available...

Carl: I think the workshops have been generally excellent and when both Peder and Doug have been in the school, if there have been technical problems they've been quick to come around and help me sort them out, including even technically malfunctioning equipment.

Diane: The support was just excellent and I think that's, if it goes, I think that's why it went—is that we knew that Peder was at the end of the phone and if we were desperate, even in the middle of a class he was there and he would definitely find us a solution. And I think any computers in education course has got to have, it's got to have that support person there. If you're using teachers who really don't know what they're doing...and usually the little things that go wrong that are the most frustrating are what turn people off. And if you have someone who will be there for you or who can solve your problem without having to spend a lot of time, and time is the bottom line, then you know that that person is there for you and you're going to use that because it makes it fun, it makes it exciting and your problems, all of the problems, the little aggravations are taken away. And that's exactly how, that's exactly what happened to us. It was wonderful. It really was. And it made all the difference...It really made a big difference—to me it made a big difference. If there hadn't been a really strong technical person there, I know I wouldn't have used it as much as I did.

As can be heard in the teachers' comments, on-going technical support, beyond the initial training stage, is crucial to the successful implementation of computers in the education system. While the needs for constant support decreased as the project progressed, the teachers still strongly felt the need for some form of support. This support came from a variety of sources, in this case mainly from Board personnel, but also from researchers or fellow teachers. Even though their confidence grew in regard to using the computers, the teachers learned to depend on that

technical support and personally to trust the Liaison. When faced with a change in support personnel, the significance of this trust can be seen in the comment by Diane:

> You know, Peder was the one person that was there for the teachers and now he is not there and I don't see how we are supposed to function when we have finally built up confidence in someone and always had the person there for us and so on, and all of a sudden that person is gone. And it doesn't matter who they bring in, they were not there for us initially, they were not the people that set this whole thing up, they have not helped us for the last how-many months to implement this thing, and I think that the project is going to be in great difficulty without him...

Time has proven that the project proceeded with a change in personnel, but this does serve to highlight the importance of dependable technical and educational support in the schools, as well as the importance of personal contact.

During the second term of observations, once the systems were well set up and running fairly smoothly, a site administrator was selected from the participant teachers and trained by Doug for each of the two schools. This seemed to serve two purposes: firstly, it allowed immediate response to certain computer problems as the person was available on site; and secondly, it offered a transition step away from a full-time technical support person for the two schools. While the availability of a Board support person was still crucial for the more serious concerns, the school site administrator was often able to solve the routine problems and maintain the system. It should be noted, however, that the site-administration duties required increased time on the part of the teachers which must be compensated for in some way. This has been further discussed under the section regarding time requirements.

Other studies have frequently cited the need for comprehensive teacher training and sustained technical support for the implementation of computers in schools. (Scrogan, 1989; Grundy et al., 1987; Catherwood and Holt, 1988; Sullivan et al., 1986; Glenn & Carrier, 1986). Our observations seem to reinforce this. While the teachers were unanimous in praising the technical support which they received from the Board's Liaisons, they expressed reluctance to continue investing time and effort in the development of new applications, unless they could be assured of continued access to both comparable hardware and adequate technical support.

The substantial costs of the technical and training support provided to this project so far should be evident, and must be included in any comprehensive cost assessment of a computer programme (Levin, 1986; Reed, 1986). Workstation and network down-time must be factored in to hardware costs, software failures must be added to software costs, and the co-ordinator's time must be added to personnel costs. Although the demands on a co-ordinator or consultant's time may decline as teachers gain experience, someone will always be required to fill such a role.

Teachers who were initially very skeptical about the use of computers in their classrooms generally became positive after attending a series of in-service training sessions. Their main concern with the training they were given is that they would have liked more time to practice. The teachers were not alone in their views that they required more training and practice time. One student complained that her teacher did not seem to know enough about a certain software package to help her solve her problems. This points to a need for greater subject-specific software training, over and above the general introduction given to all participant teachers.

In discussions with teachers regarding computer training, concerns were frequently voiced regarding the status of both in-service and pre-service training offered at the Faculties of

Education. While they felt fortunate for receiving the training provided by this project, they teachers wanted to know if all new teachers would be computer literate and what options for training were open to less-fortunate practising teachers. Following up on these concerns, we have completed a survey of the Faculties of Education in Ontario and have summarized these in the next section of this report.

3.6.2 TRAINING AVAILABLE IN ONTARIO

Following a written request to Faculties of Education in Ontario for information regarding both pre-service and in-service courses for computer training for teachers (of courses other than computer studies and computer science), a variety of responses were received. Some faculties responded with their general university calendars, while others sent personalized letters and specific courses of study, outlining content, goals, evaluation and concerns. Based on this information, a few notes should be made.

The first striking feature of the teacher education programs is the variety of levels of computer education. At one extreme there are faculties with well-developed, mandatory pre-service courses in computer education, while other programs make no mention of the offering of any computer component. While this may not necessarily mean that none are offered, it seems to give that implication. Others offer optional computer education programs for pre-service teachers, including the University of Western Ontario's *Computers in Education* elective course. Some faculties have both in-service and pre-service computer programs, while others make mention of neither or only one of the forms.

There is also a great discrepancy from faculty to faculty in the availability of computer equipment. While some faculties offer experiences with a wide variety of GEMS-approved equipment, others reported that they have a strong need for an update in their equipment, as their pre-service students are still relying solely on Commodore 64 computers.

There are further differences in the course content of the computer education which teachers are receiving. While many are very technical in nature, others include a focus on the pedagogy and the actual methods of integrating computers into the curriculum.

While many faculties had some form of pre-service computer component and three-part Ministry Additional Qualifications Courses of *Computers in the Classroom*, there were also a few exemplary programs. For example, in addition to these, York University is currently offering the in-service courses of *Computers in the Classroom for Special Educators*, *Computers and Music*, and *Multimedia and Education* as a part of the B.Ed (In-service) Programme.

While the three-part course of *Computers in the Classroom* is popular among faculties, there is a wide variety in the interpretations of the general guidelines. For example, the Ministry's course description for Part I states that a successful candidate should have:

1.1 developed competencies in the operation of microcomputers;

1.2 developed a critical awareness of the role of computers in society and the implications of this for education;

1.3 developed an awareness of the ways in which computers (with a particular focus on microcomputer) can be used to support instruction through computer aided learning;

1.4 an understanding of ways in which a computer can assist with administrative tasks within such areas as the classroom, the school and the educational system;

1.5 developed skills related to the teaching of computer literacy in the various curriculum areas;

1.6 developed skills related to the selection, evaluation and utilization of computer learning materials.

Note: This course emphasizes the use of the computer in the classroom rather than computer programming skills. This course is not a preparation for teaching specialized computer studies courses.

While these are very worthwhile objectives, outlining skills that would be useful to all educators, variations in hardware availability and personnel strengths and interests from faculty to faculty provide diversity in the programs actually delivered. While one faculty may focus on certain technical aspects of these objectives, others offer a more balanced approach. The University of Ottawa, for example, offers the following topics to achieve the aims and objectives of Part I in an exemplary fashion:

1. Introduction to educational uses of computers
2. Setting up and operating an educational computer system
3. Using the computer as a professional tool for lesson planning and record keeping (word processing, spreadsheets, databases)
4. Introduction to LOGO and classroom applications
5. Using software in the classroom
6. Evaluation of software
7. Some exemplary uses of computers in education
8. Implications of computers for social organization of classrooms
9. Ministry of Education directives and special projects
10. Board directions and support
11. Teacher and student utilities for the beginner
12. Social and historical trends and implications

Other faculties are also offering additional training with the various forms of technology, such as the Technology for Enhancing Learning (TEL) Centre at the Faculty of Education at the University of Toronto. With a mandate to promote appropriate use of technology, particularly computers and television in all aspects of teacher education (Cook and Robertson, 1991), it is also concerned with the issues we are discussing here. Ambitiously targeting faculty, student teachers, Ministry officials, practising teachers, teachers federations, school board media and computer co-ordinators and OISE, they are taking big steps towards the integration of technology into the curriculum.

While such specialized in-service and pre-service courses are offered at the faculties of education, boards of education may also offer their own in-service computer education for teachers. These may be done during school hours with supply teachers, after school hours, or on professional development days. While the first option (the method that was used for training in this project) is very cost-intensive as it requires not only the time of the computer "expert", the teachers, and the supply teachers, it offers the advantage of removing barriers to participation in such sessions, allowing more teachers a chance to take part.

Such in-service training also suggests one other method to overcoming a greater problem. Teachers presently attending Ministry computer courses do so at their own expense in time and money (each part presently costs approximately $400.00). Because it is such a major investment

on the part of the teacher, many are unwilling to complete such training, resulting in imbalances in expertise in school staffs. In-service training offered by the Board or perhaps reimbursement to the teachers willing to enrol in such programs offer more equitable opportunities. Board compensation of such courses offers a much more cost-effective means of training when one considers the costs involved in paying for the time of the trainer, the teachers, and the supply teachers needed for such experiences. An extensive and thorough introduction to computer education can be offered to teachers at a relatively inexpensive cost in this manner.

Regardless of local decisions regarding the optimal method for offering computer instruction for teachers, all participants on this project agree that it is a critical aspect of successful integration of computers across the curriculum, and one that is not to be taken lightly.

3.7 RECOMMENDATIONS

Any genuine effort to reform schools, and to incorporate information technology as a means to that reform, should recognize that, in the final analysis, teaching is in the hands of the teacher. Whatever curriculum guidelines may exist, whatever training in pedagogical techniques has gone before, the crucial events of a child's classroom experience are planned, guided, and supervised by teachers, usually acting alone. Reform efforts must therefore be aimed at altering the character of these classroom events, and to do this they must recognize the professional autonomy of the teacher and the forms of professional knowledge which teachers hold and deploy.

3.7.1 RESEARCH VERSUS EVALUATION

As we said in our first interim report, we have viewed this project from its inception as an attempt to conduct both an "evaluation" of the implementation, and as a form of "research" into the contextual influences affecting that implementation. Our research orientation has led us to examine the influences of subject subcultures, of teachers' lives and careers, and of their established styles of teaching. It has led us to examine critically both the historical development of educational computing in Ontario, and the popular ideology of computer literacy. We have found all of these contextual factors to be of great importance to an understanding of the impact of classroom computers on the ecology of schools.

It is always easier, however, to embody the results of an evaluation in a concrete set of recommendations, than it is to do so with a set of research findings. The evaluation aspects of our project were geared to improving practice; the research, to deepening our understanding. This final section must be read with this in mind.

Our research has shown that teachers structure their classes on the basis of deeply held convictions regarding their profession, and their priorities in dealing with their students. In the busy give-and-take of classrooms, they tend to fall back on their core beliefs and their practical experience to keep their classes moving forward. Teaching techniques can be changed, new approaches will be tried. Successful innovation will only occur, however, if the teacher is convinced such innovation will not be injurious to the basic processes of education he or she holds to be central, or to the established practices which have been developed as a result of these value positions. Hence, if computers in classrooms are to become an everyday part of teachers' lives, if they are to be incorporated into the repertoire of tried-and-true techniques which teachers rely on, then they must demonstrate that they are congruent with teachers' concepts and convictions regarding teaching. They must show themselves capable of meshing with the established cultures of teaching, and the subject subcultures which are so central to life in secondary schools. If they do not, they will be ignored, marginalized, or co-opted to older forms of pedagogy. They will remain "just another tool", and the restructuring of classrooms which is meant to justify their enormous cost will not be realized.

We recognize, and we urge other educators involved with information technology to realize also, that the kinds of changes envisioned by the Ministry of Education will not occur overnight. Teachers need not just hours, but weeks, months, and years of working with computers in order to begin to recognize their potential for genuinely new forms of learning. We must also recognize that the introduction of computers is not the only important innovation taking place in schools. The ways in which computers are meant to mesh with other restructuring moves, such as the

proposed de-streaming of the transition years, must be made clear to teachers. Time must be made available to them to make themselves comfortable with these innovations, and to absorb their meaning for their own practice.

In what follows, we will attempt to encapsulate the results of our evaluation project in a few over-arching recommendations. We would caution, however, that these should not be read as separate and distinct from the recommendations of each of the Principal Investigators, contained in Volume 2, nor from the research-orientated analysis which has occupied the rest of this volume. This is *not* in short, a summary of the findings of this project, but a specific attempt to define some policy implications. As the title of our project has suggested from the beginning, the importance of context is central to an understanding of the use of computers for classroom learning. If the introduction of information technologies into schools remains sensitive to the context it is entering and challenging, then it will have a far better chance of producing genuine positive change.

3.7.2 DETAILED RECOMMENDATIONS

1 Technical issues of hardware and software

1.1 Network installations

1.1.1 The Ministry has already specified that most school computers should be configured in networks, to allow for pupil-pupil interaction via the technology. Our research has indicated that most teachers would prefer to have an easily-accessible computer laboratory, with at least 20 workstations, *as well as* small clusters of computers in each classroom, connected to the same network. If forced to choose, however, teachers are divided as to their setup preferences, influenced by their subject content and teaching style.

1.1.2 In order to be productive, computer equipment must be supported by appropriate furniture, lighting, and electrical outlets. Ministry financial assistance to boards of education should recognize and fund these ancillary needs.

1.1.3 Open-access areas, whether they be labs or clusters, seem to be appreciated by students and teachers alike. Although students frequently use such areas for "recreational" computing, the value of this to later use should not be underestimated.

1.2 Software and operating systems

1.2.1 Standardization and compatibility continue to be a problem for many computer users. The GEMS specifications have helped to alleviate this in Ontario schools, and should be continued. The EASI layer and other recent industry moves toward standardized operating systems should receive continued support.

1.2.2 While the use of "tool" software, including word-processing programs, spreadsheets, and databases constitutes a large portion of computing activity in secondary schools, these activities are less productive than they could be, due to a confusing array of software packages, and different approaches to the teaching of keyboarding and typing.

1.2.2.1 A small number of standardized packages should be adopted for educational word-processing and other basic tool uses. An integrated package with word-processing, spreadsheet and database capabilities should be

investigated (the London Board, for instance, has adopted *Microsoft Works* as standard in all secondary schools).

1.2.2.2 Computer keyboard skills should be taught, at an early age, via the simplest and most straightforward method possible. Keyboarding courses should be separated from business-oriented typing courses.

1.2.3 Secondary school teachers continue to identify specific areas where customized curricular software would be useful. The Ministry should continue to support the development of such software, and should consult with a wide range of teachers on its development and evaluation.

2 Technical support

2.1 Hardware: School computers are subject to some of the harshest conditions encountered by any computer installation. Long hours, multiple users, frequent movement, and vigorous use all contribute to high wear and tear. For these reasons, school computers may be expected to experience higher than normal rates of breakage and malfunction. Unreliable or out-of-service hardware quickly degrades users' confidence in the machines, however. Whether through in-house or contracted maintenance services, boards should do whatever they can to maintain high standards of reliability and quick turn-around for repairs.

2.2 Software: As educational computer installations grow in size and complexity, the demand for on-site software and systems help will only increase. It may, in fact, eventually be necessary to have a full-time Site Administrator in every school. In the meantime, Site Administrators should be given formal training, and release time from other teaching duties, in order to better assist their colleagues. Full-time computer co-ordinators within boards can also assist in providing leadership regarding software acquisitions, board-wide standards, etc.

3 Gender equity in computer use

3.1 If there are limited numbers of computers, teachers should not use a first-come, first-served system; rather, sign-up sheets should be used. Access to optional computer time must be structured to ensure equal opportunity. Until equal use is established, it may be necessary to target female students specifically for computer use.

3.2 The social aspect of computing should be stressed, as adolescent girls have a strong need for social contact. Therefore, strategies should be targeted to groups rather than to individuals. Students should be allowed to work in pairs or groups, preferably single-sex groupings for greater gender equity.

3.3 Software should be selected to appeal to females, who are generally not interested in violent programs; non-sexist programs should be selected.

3.4 Computer activities should be designed around girls' existing interests as well. Many girls are fascinated by graphics; however, not all girls "naturally" want to use a computer for writing, art, and music; opportunities should also be provided for those who prefer subjects such as math, science, and metal shop.

3.5 The image of the computer room as primarily male territory must be removed.

3.6 Females should be selected as role models for students and educators involved with computer use.

4 Training

4.1 The bulk of educational computer training to date has been concentrated on in-service preparation of teachers. This is to be expected, as there is presently a large cohort of teachers in schools who are not familiar with computer use. For best results, this must be combined with strategic planning regarding pre-service training. Greater consistency among the faculties of education, both in terms of courses offered and in hardware availability, would be an asset.

4.2 In-service training sessions should concentrate on a small number of programs at a time, and should include adequate time for teachers to practice and experiment with what they have learned. This training could take several forms, depending on local needs and resources:

4.2.1 In-service training similar to what the project's participant teachers received, with one day a week release time and workshops for a month, with additional workshops as necessary; or

4.2.2 Releasing interested teachers from teaching responsibilities for one period for one term in order to attend workshops, familiarize themselves with software, and design appropriate implementation strategies; or

4.2.3 Board subsidy of teachers' tuition for Ministry-run Additional Qualifications courses held during the summer and night school, or other night courses held in the community, specifically dealing with the software packages.

4.3 Following the initial training offered to teachers in one of the above manners, there must be an on-going commitment to computing:

4.3.1 Boards should strive to incorporate specific computer-related topics into their offerings on Professional Development days. These could be both general and subject-specific.

4.3.2 Teachers must be provided the time to keep up-to-date with the hardware and software and to explore the potential of computer use in their subject area, in order to fully integrate computers into their curriculum.

4.4 Additional or revised Ministry courses might also be offered, dealing with some of these more specific issues. This would allow all teachers to receive academic and professional credits for the development of their knowledge of how to integrate computers into subject-specific areas.

4.5 It is important to recognize that training for secondary school teachers is training in subject-specific knowledge. Although much of the training observed and reported in this report deals with the more technical aspects of computer technology, it is crucial to grasp that a great deal of future professional development needs to be grounded in subject-specific knowledge. If computer technology is truly to take root in Ontario schools, it will be because teachers plan classroom events with such technology in mind. Since classroom events, themselves, are grounded in subject-specific knowledge, it is therefore crucial that training for computer technology should be heavily focused at this level.

4.6 The Ministry of Education should support the above activities by supporting the efforts of faculties of education. It can do this by subsidizing the development of further Additional Qualifications courses in faculties, and by assisting them in obtaining the latest GEMS equipment.

4.7 Whether training in computer-aided pedagogy is conducted prior to or during teachers' active service, there should be a consistent emphasis on the ways computers can be used to introduce new forms of collaborative, student-centred learning. Without this emphasis, computers in classrooms risk being ignored, marginalized or co-opted into older forms of teaching.

Appendix 3.1:
Facsimile of RUCCUS Interaction Analysis/Cognitive Patterns Tracking Sheet

Location: ___ Regular Classroom
___ Computer Classroom
___ Computer Lab

Teacher: _____ Date: _______ Topic(s)/Software: ____________
Observer: _____ Time: _______ Time Unit: ____________

Learning Activity UNCAL/ Bloom	TEACHER TALK			PUPIL TALK			Silence	TOTAL
	Initiation	Questions	Response	Response	Initiation	Pupil-Pupil Interaction		
Recognition/ Recall								
Reconstructive Understanding/ Comprehension/ Application								
Global Reconstructive/ Intuitive Understanding/ Analysis								
Constructive Understanding/ Synthesis/ Evaluation								
TOTAL								

Individual/Small Group Instruction	Collective/Large Group Instruction

Confusion/Non-Instructional Activity

Total Instructional	Total Confusion/NIA	Grand Total

UNCAL Learner-CAL Interactions
Recognition—yes/no, multiple choice questions
Recall—fill-in-the-blank, recitation
Reconstructive Understanding/Comprehension—paraphrase, comprehend statements, concepts and principles
Global Reconstructive/Intuitive Understanding—controlled by student; discovering principles behind simulations, problem-solving
Constructive Understanding—open-ended, student creates new knowledge; original thought

RUCCUS/Flanders Interactions
Teacher initiation—lecturing, giving directions, criticizing or justifying authority
Teacher questions—asks questions of group or individual
Teacher response—accepts feeling; praises or encourages; accepts or uses ideas of pupils

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